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ABSTRACT

Radiation workers, by law, have the responsibility to maintain their exposure to radiation levels as low as possible. This responsibility has not been accepted. Instead, they have relied solely on the policing action of health physics (HP) technicians, thereby delegating their lawful responsibility. Continued overexposure in the U.S. nuclear power plants show that this method of protection does not work. A project was designed and implemented to provide training to 10 Shoreham Nuclear Power Station radiation workers to enable them to monitor their own dose, identify changing conditions, and fulfill their responsiblity for self-limitation of exposure. A training plan was developed using the Institute for Nuclear Power Operations Training Systems Design, a process involving DACUM analysis, design of enabling objectives, development of instructional activities corresponding to instructional events described by Gagne (1985), training program implementation, and evaluation. The method of instruction was an illustrated talk with demonstration and student practice. The talk and practice were in three parts in the order of the likelihood of hazard: radiation, contamination, and airborne assessment. Identification for each hazard was practiced separately in the lesson, which was followed by laboratory practice where the trainer performed hazard assessment for all three radiological conditions existing at the same time in a mock-up work area. Formative evaluation techniques, including two small group trials and pilot test, resulted in improved mock-up training scenarios. One hundred percent mastery was required and attained by the trainees. (The report contains 20 appendices of project materials and a 19-item bibliography.) (NLL)

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A RADIOLOGICAL ASSESSMENT SKILLS TRAINING PROGRAM FOR THE RADIATION WORKER AT SHOREHAM NUCLEAR POWER STATION

by

Leonard Engel, Jr.

B.S. 1964, U.S. Naval Academy

A Thesis/Project

submitted to the Faculty of the

School of Media and Arts

of the New York Institute of Technology in partial satisfaction
of the requirements for the degree of

Master of Science

June 11, 1989

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THESIS/PROJECT

by

LEONARD E. ENGEL JR.

submitted to the faculty of the
School of Media and Arts

of

NEW YORK INSTITUTE OF TECHNOLOGY

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

TRAINING AND LEARNING TECHNOLOGY

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THE SCHOOL OF MEDIA AND ARTS

of

NEW YORK INSTITUTE OF TECHNOLOGY

announces the

Final Examination

of

Leonard E. Engel Jr.

for the degree of

MASTER OF SCIENCE

in

TRAINING AND LEARNING TECHNOLOGY

A Radiological Assessment Skills Training Program for the Radiation Worker at Shoreham Nuclear Power Station

Abstract

This is a report and examination of the analysis, design, development, implementation, and evaluation of a training module to instruct nuclear utility radiation workers in the skills necessary to identify and monitor radiological conditions and anticipate changes to these conditions. The Institute for Nuclear Power Operations Training System Design process was utilized. The method of instruction was an illustrated talk with demonstration and student practice. The talk and practice is in three parts in the order of the likelihood of hazard: radiation, contamination, and airborne assessment. Identification for each hazard was practiced separately in the lesson. The lesson is followed by laboratory practice where the trainer performs hazard assessment for all three radiological conditions existing at the same time in a mock-up work area.

Formative evaluation techniques, including two small group trials and pilot test, resulted in improved mock-up training scenarios. The training was delivered to ten Shoreham radiation workers at Long Island Lighting Company's J.W. Dye, Jr. Training Center in Hauppauge New York. One hundred percent mastery was required and attained by the trainees.

Friday, May 19, 1989 at 9:00 a.m.

in

Conference Room, French Chateau
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Old Westbury, NY

CE053073

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It takes four coordinates to determine a position in space and time. The position of this thesis in time has been established by the four dimensions of mentor, resource, facilitator, and advocate.

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Opening Statement

"A plausible impossibility is always
preferable to an unconvincing possibility."

- Aristotle, *Poetics*

CHAPTER 1

INTRODUCTION

Overview

In the industrial world, workers are exposed to hazards both in "process" and "waste" production. The law requires identification, control, and risk assessment. The individual worker is the one who is responsible for individual health, to limit individual risk, often based on the information provided by the employer. The employer, therefore, must provide accurate information and manage the hazards within acceptable limits, to provide general protection to the public. So it is in the world of nuclear power: risk assessment, hazard identification and management, and workers responsibility for their own health and exposure to any hazard. The nuclear power hazard is radiation. The worker is responsible for limiting exposure to levels as low as reasonably achievable (ALARA). This is the law.

Background

At LILCO's Shoreham Nuclear Power Station, the worker has had no problem in limiting exposure. There is no radiation area. For several years the plant has been struggling to operate. In anticipation of a 100 per cent operating license, personnel are in transition between pre-operational and operational status. The struggle has been so long and rigorous that many personnel have left, and the staff is heavily supplemented by contractors and consultants. In the area of radiation protection, workers will have to exercise self- responsibility for limiting dose (exposure to radiation). There are sufficient Health Physics (HP) staff to manage dose control programs and control work in potential radiation areas with radiation work permits (RWP), but their numbers are insufficient to "police the action" in low dose areas. During this transition phase, workers in radiation areas (radiation workers) must monitor their own dose within the parameters of the RWP. If there are

changes in radiological conditions that are identified in the permit, they must leave the work area and seek HP assistance. Most of the radiation workers appear lazy as they rely on being policed. HP technicians have always accompanied radiation workers;
monitoring radiation and anticipating changing radiological conditions for them.

As can be seen, the structure of the health physics staff has been vertical, existing in parallel to the other specific plant worker vertical structures: radiochemistry technicians, instrumentation and control technicians, engineers, and maintenance personnel. Training radiation workers to be independent in low dose areas results in a horizontal structure for them, allowing the exercise of dose control responsibility from within their own work discipline. This horizontal structure is now used by Canadian and Swedish nuclear power plants (Rippon, 1988). When they operated with the vertical structure, overexposure incidents (exceeding limits on allowed radiation exposure) continued, as they have in the United States. Health physics personnel could not anticipate worker actions despite careful planning. It's the worker's turning a valve, pulling a cable or drawing a sample that will cause a radiation field to change significantly. The worker knows best when the valve will be turned, pump started or detector pulled from the core. Since switching to a horizontal structure, overexposure incidents no longer occur in Canada or Sweden.

As the designer developed this project on radiation worker training, an overexposure incident at a U.S. nuclear power plant resulted from a worker initiated activity that was not communicated to the HP technician monitoring the job. Policing, again, did not work.

Statement of the Problem

Radiation workers, by law, have the responsibility to maintain their exposure to radiation levels as low as reasonably achievable. This responsibility has not been accepted. Instead, they have relied solely on the policing action of health physics technicians, thereby delegating their lawful responsibility. Continued overexposure in U.S. nuclear power plants show that this method of protection doesn't work. Out of necessity, Shoreham will require workers to exercise dose control responsibilities in low radiation areas. To achieve this self-sufficiency, additional skills training is required.

Purpose of the Project

The purpose of this project is to provide training to radiation workers to enable them to monitor their own dose, identify changing conditions, and fulfill their responsibility for limiting exposure. In the process, the need for the HP policeman is eliminated. This has three advantages: (1) there is less exposure (2) the need for HP contractors is reduced (3) each collective job dose is reduced by one person.

Definition of Terms

Radiation is the product of radioactivity. Many terms are used to describe this product and its effects as well as the field of health physics - the science of radiation control. For the reader's convenience, these terms are defined in the Radiological Health Handbook (1970).

Absorption - The process by which radiation imparts some or all of its energy to any material through which it passes

Activation - The process of inducing radioactivity by irradiation

Activity - The number of nuclear transformations occurring in a given quantity of material per unit time

Alpha Particle - A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude to that of a helium nucleus (2 protons and 2 neutrons)

Attenuation - The process by which a beam of radiation is reduced in intensity when passing through some material

Beta - Charged particle emitted from the nucleus of an atom, with a mass and charge equal in magnitude to that of the electron

Calibration - Determination of variation from standard, or accuracy, of a measuring instrument

Contamination - Deposition of radioactive material in any place where it is not desired, particularly where its presence may be harmful

Controlled Area - A defined area in which the occupational exposure of personnel (to radiation) is under the supervision of the Radiation Protection Supervisor

Curie - The special unit of activity; one curie equals 3.700 X 10^{10} nuclear transformations per second

DACUM - Develop A Curriculum process

Decay - Disintegration of the nucleus of an unstable nuclide by spontaneous emission of charged particles and/or photons.

Detector - Any device for measuring radiant energy

Dose - A general form denoting the quantity of radiation or energy absorbed

Permissible Dose - The dose of radiation which may be received by an individual within a specified period with expectation of no significantly harmful result

Dose Rate - Absorbed dose delivered per unit time

Exposure - A measure of the ionization produced in air by x or gamma radiation

Fission Products - Elements or compounds resulting from fission

Fuel Flea - An often invisible particle of fuel with a high static charge

Gamma Ray - Short wave length electromagnetic radiation of nuclear origin

Half-life - Time required for a radioactive substance to lose 50 percent of its activity by decay. Each nuclide has a unique half-life.

Health Physics - A science and profession devoted to the protection of man and his environment from unnecessary radiation exposure

Ionization - The process by which a neutral atom or molecule acquires a positive or negative charge

Ionization Chamber - An instrument designed to measure a quantity of ionizing radiation in terms of the charge of electricity associated with ions produced within a defined volume

Monitoring - Periodic or continuance determination of the amount of ionizing radiation or radioactive contamination present in an occupied region

Nuclide - A species of atom characterized by the constitution of its nucleus

Parent - A radionuclide which, upon disintegration, yields a specified nuclide

Photon - A quantity of electromagnetic energy

Rad - The unit of absorbed dose in any medium

Radiation - The emission and propagation of energy through space or through a material in the form of waves

Radioactivity - The property of certain nuclides of spontaneously emitting particles or gamma radiation

Radiochemistry - The aspects of chemistry connected with radionuclides and their properties

Survey - Evaluation of the radiation hazards incident to the production, use or existence of radioactive materials

Assumptions

1. That the Shoreham Nuclear Power Station (SNPS) will be licensed and operate. This condition is met as long as an operating license is pursued.

2. That each radiation worker has completed SNPS general employee training (GET) levels 1 and 2, as well as ALARA and quality assurance indoctrination (QAI) training.

Limitations

1. That the training is Shoreham specific and may not be suitable for other nuclear power plants.

2. That management must be committed to limiting dose (ALARA) and that commitment be reflected in established goals for radiation workers.

3. That any training in radiation areas be simulated because of the statistical increase in cancer risk associated with absorbed dose.

Methods and Procedures

The designer will observe radiation workers in potential radiation areas. A videotape will be made of the only radiation exposure job at SNPS, and a radiation worker questionnaire and interviews will be conducted.

This training plan is to be developed using the Institute for Nuclear Power Operations (INPO, 1985) training system design (TSD). The process includes the five phases of analysis, design, development, implementation, and evaluation.

Analysis

Radiochemistry technicians, instrumentation control technicians, health physics technicians, and supervisors were brought together to participate in a DACUM Analysis (1985) of the job of radiation worker dose control and health physics self-sufficiency. Tasks were identified for analysis. Nuclear journals, NRC bulletins, and INPO inspection reports were researched.

Design

Enabling objectives were developed from the tasks and steps identified during the DACUM Analysis. The Mager (1984) methodology of using performance under given conditions, to specified criteria was carefully utilized.

Development

At this point INPO requires utilization of nine instructional activities which correspond to the instructional events described by Gagne' (1985). These events are the foundation of the training. The method of instruction will be an illustrated talk with extensive class participation, discussion, and demonstration. This is to be followed by a practice laboratory in radiological assessment using job sheets specific to radiation worker discipline. Changing conditions are to be explored in an interactive Computer Based Training (CBT) module. This is followed by on the job training (OJT) and finally qualification.

Implementation

Training, as designed, was given three times to six radiochemistry technicians and four contractor technicians. After modifications and plant licensure, it will be given to all radiation workers and contract technicians as they arrive on site.

Evaluation

Small group testing and field trials were conducted. Formative evaluation resulted in more changes. On the job training was conducted by OJT trained SNPS technicians. Summative evaluation will be performed when Shoreham is operational.

Summary

The training plan described is similar to teaching defensive driving. Certainly anyone on the street, behind the wheel, has a responsibility to avoid collision. There are lots of rules and lots of policemen, yet immature and inexperienced drivers try to get away with breaking the rules. They are risking their lives. In a radiation field, the radiation worker is behind the wheel in a controlled collision. The vehicle is reinforced for extra protection, but the worker is at risk. The controls for the collision are the rules and program management. Going from point A to point B, working in radiation areas, involves detailed road signs (RWP), stop signs (hold points), and caution lights (potential for change), that occasionally change to red ...

CHAPTER 2

ANALYSIS

Introduction

Analysis revealed first whether there was a training need or a management problem, then it identified new job requirements and specific performance tasks. At Shoreham a health physics questionnaire and interviews revealed radiation worker performance problems. An additional job requirement led to additional tasks. The tasks were identified by subject matter experts (SME) and the workers themselves using the DACUM Method (1985). Analysis revealed:

- Performance problem training needs
- New job tasks
- Enabling knowledge, skills, and attitudes
- SNPS constraints and budget
- Existing course materials

Needs Analysis

Radiation worker performance in operating nuclear power plants continues to result in overexposure incidents. The Nuclear Regulatory Commission regional review found that key factors contributed to these incidents:

- Failure to evaluate radiation hazards

- Insufficient radiological controls
- Lack of communication
- Lack of management oversight

Shoreham health physics has chosen to concentrate on management control and specific radiation work permit controls, with hold points, where radiological conditions could change. Radiation workers will be required to accept more responsibility. The workers read radiological survey maps, verify radiological hazards and monitor their own low dose area jobs. Health physics has rewritten their procedures for radiation work area control, getting involved earlier in the planning stages. These changes reflect the transition from pre-operational to operational status. More control is required of management, and more responsibility is required of the radiation worker.

Preoperational status for Shoreham has been a matter of "years" rather than the expected "months" normally required to go from low power testing to full power operation. The NRC sent a "readiness" team of 17 inspectors . It now looks as though licensure is just around the corner.

The designer and HP supervisor questioned 38 radiation workers as part of the readiness procedure for a Shoreham start-up. Seventeen questions were asked in critical areas (See Appendix A) as summarized in Table 1.

Table 1

Radiation Worker Readiness Questionnaire

Question Area	Priority	No. of Questions	Correct Answers	Incorrect Answers	Percent Correct
1. Monitor absorbed dose in radiation areas	4	3	95	19	83.3
2. Dose limits & guidelines	1	3	39	75	34.2
3. Radiation work permits and ALARA	3	3	76	38	66.7
4. Hazard identification and response	2	6	146	74	66.4
5. Radiological control and responsibility	5	2	76	0	

The workers understand their responsibility, but don't have the information necessary to act on that responsibility. Being trained for operational status while the plant continues to remain pre-operational causes problems. There needs to be extensive use of simulation and mockup training.

Job Task Analysis

The DACUM (1985) Method was used to zero in on tasks and specific performance steps needed to enable the radiation worker to exercise dose control responsibility and independence in low dose areas. Radiation workers were represented by two radiochemistry technicians, two instrumentation and control technicians, two health physics technicians, one supervisor, and one engineer. See the DACUM chart Appendix B. Four tasks were identified:

A. Perform a radiation survey

B. Perform a contamination survey

C. Obtain an air sample

D. Identify changing conditions

Target Population Analysis

The target audience is the radiation worker. A radiation worker may be a technician, maintenance personnel, contractor or consultant. Shoreham is relying heavily on contractors and consultants.They will be at least high school graduates with a minimum of three years operating plant experience and meet the American National Standards Institute (ANSI, 1972) requirements for their field. Presently Shoreham has employed engineering consultants, health physics technician contractors, radiochemistry technician contractors, instrumentation and control contractors, and maintenance contractors. Education is in general at the baccalaureate level. It should be noted here that each contractor will receive GET 1 and 2 as well as ALARA and Quality Assurance Indoctrination (QAI) training at LILCO's J. W. Dye, Jr. Training Center. Shoreham in-house technicians are summarized in Tables 2 and 3.

Table 2

Radiochemistry Technicians

Number of Technicians	Years Navy Nuclear	Years Operating Plant	Years at LILCO	Education
1	0	0	3	Ph.D
2	0	0	2	MS
3	0	0	4 - 6	BS
5	6 - 8	0	4	AS
2	0	0	2	HS

Total Radiochemistry Technicians: 13

The in- house staff is supplemented by 5 contractor technicians whose experience range from 3 years to 10 years in operating nuclear power plants. The Instrumentation and Control staff are also supplemented by contractor technicians who make up for the lack of operating nuclear power plant experience. See Table 3.

Table 3

Instrumentation and Control Technicians

Number of Technicians	Years Navy Nuclear	Years Operating Plant	Years at LILCO	Education
15	6 - 8	0	2 - 6	AS
13	0	0	3 - 6	AS
1	6	0	8	BS

Total Instrumentation and Control Technicians: 29

The nuclear experience of both groups has been with the Navy nuclear program. These workers have a strong background in radiation protection, but don't have any nuclear power plant experience. Most have spent one to three months as part of a personnel exchange at the Nine Mile Point plant in Oswego, New York.

Organizational Constraints

The obvious constraint for Shoreham is operational status. Training is limited to technicians until the operating license is issued.

Instructional Goal

In identifying the instructional goal, the designer used the Dick and Carey (1985) methodology of defining the gap between "what is" and "what should be." This is described in Table 4 .

Table 4

The Problem Gap

What is	What should be
1. Shoreham pre-operational	Shoreham operational
2. Dependence on contractors	Full complement staffing
3. Health physics technician policing action	HP technicians managing jobs
4. Radiation workers delegating their responsibility for dose minimization	Radiation workers exercising dose control responsibilities
5. Radiation workers relying on HP for identifying any radiological hazards and changing conditions	Radiation workers identifying radiological hazards and changing conditions.
6. Workers receiving minimal practice in simulated radiological conditions	Practice in mockups using radiological simulation

Items 1, 2, and 3 are the management problems related to 4, 5, and 6. Instruction and practice will fill the gap of 4, 5, and 6. The goal has been derived from an informal readiness assessment and the learners themselves in a job analysis. It is written in terms of learner outcomes:

> The radiation workers at Shoreham will exercise their lawful responsibility for limiting dose to levels as low as reasonably achievable as compared to Swedish and European plants (See Appendix U). When working in low dose areas, under a radiation work permit with dose rates less than 100 mRem/hr, they will (1) perform independent radiological surveys for hazard assessment and (2) identify changing radiological conditions.

Goal Related Concerns

Availability of students was the designer's first concern. It was decided to include this training as part of the continuing training program, beginning with radiochemistry technicians. The students would be at LILCO's J.W. Dye Jr. Training Center where the HP laboratory, radiochemistry laboratory, and mock- up rooms could be used to simulate various work areas and changing radiological conditions. Lots of practice would be needed before going back to the plant and qualifying.

The goal is clearly linked to exercising every worker's primary goal of limiting individual dose (ALARA). There is some question as to whether the workers would see it this way. After all, HP's have always done the radiological surveys before. Is the training going to make the worker an HP? The classroom will have to be a very open one with the instructors facilitating discussion and shared concerns. Both affective and cognitive domains (Bloom, 1956) are involved. The laboratory practice, following the illustrated talk, with demonstration, will have to be worker specific. The job sheets must contain realistic scenarios that are Shoreham and radiation worker specific. Some workers will require more practice than others, so there will need to be a variety of scenarios and study options for the accelerated and slower learner.

Goal Related to Prerequisite Training

This training program builds on the skills learned in General Employee Training 1 and 2, quality assurance indoctrination, as well as dose control training (ALARA). Knowledge of radiological hazards will be applied in this training program when that radiation is measured with a meter. Beginning skills in reading survey maps are applied at a higher cognitive level when survey maps are compared to identify changing conditions. Dose control limitations and guidelines will be applied when radiation workers calculate their stay time.

Goal Related to Method

Instructional media were selected using the Anderson (1983) selection process. To set the stage for learning, the trainees will view a video tape of the only dose job at SNPS, removing an in-core detector. They will be asked to identify worker and HP job tasks. Then they will be asked how they feel about performing both HP and worker tasks themselves. Actual survey instruments and samplers will be demonstrated in the lesson. A model ion chamber will be used in the laboratory so that dose rates can be simulated by the instructor via remote control. Printed handouts, white board, easel and transparencies will be used to enhance cognitive concepts, discriminations, and manipulative skills. Human and situational resources will be used in case studies and group decision making in overexposure incident information provided by INPO. The design consists of an affective-cognitive-affective approach, with ample, individual practice.

The DACUM Method, in addition to identifying the tasks in the duty area of "independent radiological assessment," also identifies the knowledge and skills for each task. These analysis work sheets are contained in Appendix C. Some of the knowledge statements were selected for training; others identified as prerequisites are contained in GET 1, 2 or ALARA courses. The tasks were verified by the health physics engineer.

Literature, Existing Course, and Material Review

A literature search was conducted at New York Institute of Technology utilizing the DOE Energy database via the Dialog Information Retrieval Service. The designer also used the information center at the J.W. Dye Jr. Training Center. The center contains an excellent collection of nuclear power and training journals. There is also a complete collection of NRC and INPO reports, good practices and bulletins.

Related Theory

Carl Rogers (1969) has long championed the cause of a unified theme in learning: the value of combining experiential with cognitive learning. Cognitive and the affective-experiential must be brought together in awareness for the radiation worker to be able to exercise maximum caution, self-discipline, and self-confidence.

Ausubel (1968) is an advocate of "intellectual scaffolding" to structure ideas and facts, mastery of academic material. At first glance, when compared to Rogers, he is at the opposite end of the spectrum. Note that he believes if the learner begins with the right "set," learning can occur. Rogers' theory provides the "set" and Ausubel the cognitive key for connecting new material (as identified in DACUM) with existing ideas in the learner's cognitive structure. This is why the radiation worker must have GET 1 and 2, ALARA and QAI before beginning the course designed in this project. The trainees will take the new material and translate it into their own frame of reference, their own job discipline, and their own words. The instructor must be a Rogerian "facilitator" consciously making linkages with radiation theory, dose limiting, and quality concepts of the prior courses. This is followed by practice in the laboratory. Mastery of objectives is essential.

According to Bloom (1956), the instructional goal encompasses both the affective and cognitive domains which are summarized in Table 5, from simple to complex.

Table 5

Bloom's Taxonomies

Affective	Cognitive
Receiving	Knowledge
Responding	Comprehension
Valuing	Application
Organization	Analysis/Synthesis
Characterization by a Value	Evaluation

Literature Review

The NYIT literature search utilized Dialog information retrieval services and the DOE energy database. The descriptor "nuclear power plant" yielded 17,747 items. Combining this with "training workers" yielded 4 items. "Personnel in nuclear power plants" yielded 1,439. Changing the descriptor to "radiation safety" yielded 17,526 items. Narrowing the focus to "reactor operation" yielded 5,782 items; "reactor operation and engineering" yielded 51 items. Forty-one abstracts were reviewed including journal articles, reports, conference literature and books.

Many of the articles dealt with emergency preparedness, hazardous waste and nuclear operator training. This has been the focus of the NRC and other agencies. The Institute for Nuclear Power Operations appears to be alone in addressing the needs of the radiation worker, in the form of general employee training and job tasks training specific to worker discipline. Out of the forty-one, the designer found the following articles to be significant:

1. **Development of a Training Assurance Program** (Palchinsky, J., Waylett, W.J. Jr., 1987). The article was included in the proceedings of the Committee on the Safety of Nuclear Installations meeting on the training of nuclear reactor personnel. This article points out that the nuclear industry has made significant resource allocations for INPO accredited performance-based training programs. How does management know if the training is

effective? Florida Power and Light has integrated its training with the quality assurance process (QA). The result is that the personnel function has become proactive. The descriptors were nuclear power plants: personnel; personnel training.

2. **Training the Duke Power Way** (Nuclear News, 28, 49-54). Duke Power builds its own plants. This independence is reflected in its training programs, dating back to 1967. The author describes the history of their training program, accreditation process and efforts to make programs accountable through evaluation feedback. The independence in development demands more investigation. The descriptors were nuclear power plants: personnel management; reactor operation, training, learning, standards.

3. **Characterization of the Radiation Work Force at U.S. Nuclear Power Plants** (Cehn, J.I., Hambrecht, R. 1984). This article gives a profile of the imaginary radiation worker, "Lenny." He is a composite of the 22,000 radiation workers employed during outages at nuclear power plants. Lenny reports to a trailer on the plant site to check in, then spends the next few days in training classes covering radiation safety, exposure limits, federal regulations and plant procedures. Next comes the exposure and medical history. The author asks a key question: Is Lenny assigned all the dirty work (meaning high radiation exposure work)? Is he a "glowboy," a "radiation sponge?" Interestingly, the study shows that permanent staff

receive nearly the same annual dose as outage radiation workers. The author neglects to point out that many of these outage radiation workers will work only six months a year. The descriptors were nuclear power plants: personnel; nuclear power plants, radiation hazards; radiation protection, personnel; personnel,training, radiation dose.

4. **Dimensions of Performance-Based Training Management** (Cookley, W.T., 1985). The article was presented at the sixth symposium on the training of nuclear facility personnel in Nashville, TN. on April 15, 1985. The author points out that the responsibility for various aspects of training is distributed among several organizational units. The successful integration of the various elements of a training system, in the presence of divided functional responsibilities, is a real management challenge. INPO gives observations of training management practices. The descriptors were nuclear power plants: personnel, training, program management.

The NYIT research was a good start, opening up three areas for further research: (1) Duke Power's independent work in training; (2) the linkage with quality assurance and management; and (3) the proceedings of the committee on the Safety of Nuclear Installations (CSNI) specialist meeting on training nuclear reactor personnel conducted in April 1987. The information center at LILCO's J.W. Dye Jr. Training Center had the complete CSNI proceedings, and Radiation Protection Management journals with articles on Duke management.

5. **Duke Power Company's Independent Radiation Worker Program** (Lewis, L., Yongue, C., 1987) This article summarizes an independent program for training radiation workers to become health physics technicians. After their training, they are not used in their own job discipline, but more as an HP staff supplement. An interview with the trainees showed that they felt like second class citizens: HP's, but not quite. The approach was ,different from this project.

6. **An Instructional Approach to Increase Trainee Learning Through Improved Laboratory/Simulated Exercises** (Sales, J., Oxford-Grigg, J., 1987). From the CSNI proceedings held in Orlando, Florida in April 1987, came the most useful article. The proceedings were sponsored by the NRC and National Academy for Nuclear Training. Specific guidelines were outlined for planning, preparing, conducting, and evaluating laboratory sessions. There was also a discussion of six problems that produce ineffective labs.

7. **Achieving Low Doses at Scandinavian Plants** (Rippon, S., 1988). This was the kick off article that launched this project. Good practices at the Forsmark Swedish Plant showed the success of the horizontal approach to health physics training. Radiation workers were trained to be self-sufficient within their own job disciplines.

NRC information bulletins and INPO significant operating event reports were reviewed for overexposure incidents and good practices as well as ALARA and dose control information. This information was compiled in case study format.

Survey of Existing Courses and Materials

In 1988 General Physics began offering a "case study service" for nuclear power plants program. One lesson plan with student handouts and suggested readings would be offered each quarter. In reviewing the five available lessons, three apply to this project. A lesson on "Radiation Surprises" discusses overexposure incidents. A lesson on activation and "hot particles" and one on"survey pitfalls" emphasize changing conditions. Each use the case study approach, offering ideas for stimulating discussion. They were excellent. The focus is on the radiation worker and changing radiological conditions. The only problems were the poorly worded and inappropriate questions at the end of each lesson. In the module on activation particles and fuel fleas, too much time was spent on the analysis of individual particles, when a single representative particle would have been simpler and sufficient. The three modules made the case study series worth purchasing for $5,000. The case studies will help the trainee understand the importance of caution and planning when working in radiation areas. It fills a need in the affective domain.

NSS offers two slide/tape presentations. The first is the "physics of ionizing radiation." This would be a good refresher for those trainees that may have had difficulty in the prerequisite courses GET 1 and 2. The second is on activation products and reactor isotopes. This was identified in the task analysis and was used in place of a CBT module, for now. Both were in LILCO's information center at the training center, and will be used in the project. Finally, NUS has the capability to develop and implement this project on a cost-plus basis.

Plan for Design and Development Effort

Using the INPO training system design process (TSD), the project was planned from start January 1988 to finish April 1989. The political question on Shoreham licensure became integral to the process.

Project Plan

A Gantt chart was created to track the radiation worker project from start to finish. See Appendix D. One target date was established, March 3, 1989. The training plan would be due, and the NRC would have their decision on licensing Shoreham (thirty days after the decision). Politics is integral to most decisions made at Shoreham. There are many check points, with decisions on whether to continue. The real question seems to be, is there a nuclear operating budget?

Budget

The J. W. Dye, Jr. Training Center is available to this project, including audio-visual support. The training will be included as part of continuing training, required by the NRC and INPO managed. The cost for attendance by trainees is $6000. The DACUM process required six job incumbents at a cost of $1000. The designer/subject matter expert labor charge is $70 per hour for the duration of the project. All materials, classroom, laboratory, and office space are provided by the training center. The total cost is $51,840. See Appendix E.

Summary

This project is to train the radiation worker to (1) overcome an indicated performance problem, and (2) enable the worker to become self-sufficient in health physics in low dose radiation areas. The DACUM method was used with job incumbents, a cross section of Shoreham radiation workers, and health physics technicians. Together they identified four performance tasks for radiological assessment. It was decided to include changing radiological conditions as part of the three surveys for radiological assessment, radiation, contamination, and airborne. Task analysis then revealed the knowledge and skills to be selected for training. The target audience was identified, prerequisites established, and instructional goal written in terms of lesson outcomes. Finally literature, existing courses and materials were reviewed.

CHAPTER 3

DESIGN

Introduction

The process of analysis can yield nothing - or it can yield the products for design. The job for the radiation worker now includes the product of four additional tasks. These are composed of elements or steps and broken down into corresponding knowledge and skill requisites. These products begin the design phase.

After the health physics engineer validated the tasks established by the DACUM committee, some of the knowledge and skills were identified for pre-course training. Tasks, elements and remaining knowledge and skill items were selected for this training project. Job performance measures (JPM) were then developed giving each step of each task the measurable criteria needed for procedural and lawful compliance. Given the JPM's, the training settings were established, learning objectives written and sequenced, and evaluation methods selected for measuring mastery. Trainee entry-level knowledge and skill items were established. Learning objectives were organized and tests constructed. Some existing materials were selected for use. The complete training plan could now be written - and so it was.

Instructional Task Analysis

The DACUM committee did an excellent job in identifying the tasks and performance steps, including the supporting knowledge/skills. Task analysis work sheets were submitted for verification by the plant health physics engineer. The work sheets are in Appendix F and include the following:

- Task title
- Conditions
- Standards
- Materials/references/equipment
- Initiating cues
- Terminating cues
- Consequences of inadequate performance
- Safety considerations
- Comments

The three radiological surveys were selected for training; but it was decided that changing conditions be included in each survey, using a laboratory setting, rather than treating it as a task by itself.

The task steps were expanded to include health physics procedure requirements and job performance measures were then written. See Appendix G. The tasks are sequenced by likelihood of hazard and the steps are in the order of performance. The DACUM identified steps were labeled "C" for critical. It was decided that failure to perform a critical step to the standard given constitutes failure in task performance. This would then require additional instruction or guided practice .

Instructional Objectives

Performing radiological surveys under carefully controlled conditions involves both affective and cognitive domains. It will require classroom, laboratory, and mockup settings at the J.W. Dye, Jr. Training Center. The instructional objectives are in the Mager (1984) format of criterion-referenced performance under given conditions. See JPM's Appendix G, and lesson objectives in a student handout format in Appendix H. These cognitive objectives remain tied to a performance step . Performance mastery (100%) is the goal.

Entry Behaviors Defined

Most of the technicians in the target population have had extensive radiation protection training in the Navy. If not Navy, they are contractors, with at least three years operating plant experience and INPO accredited training at each facility. Three courses are required for entry into the radiological assessment skills training. The courses, with brief description, are summarized below.

1. **General Employee Training (GET) Level 1**	This is a 6 hour course for anyone working in a nuclear power plant. Radiation nomenclature, ionizing radiation, and biological effects are presented.
2. **General Employee Training (GET) Level 2**	This 6 hour course is specifically for the radiation worker. The theory of Level 1 is applied in reading survey maps, using protective clothing, and frisking.
3. **Quality Assurance Indoctrination (QAI)**	A 4 hour course emphasizing the quality assurance requirement at SNPS.

The knowledge and skills tagged (*) in Appendix C are included in the three prerequisite courses.

Group and Sequence Objectives

Radiation workers work in radiation areas. These areas may be contaminated, and if highly contaminated, may also contain airborne radioactivity. The objectives were grouped according to radiological hazard from the most likely to the least likely to occur. Within each group the objectives were sequenced in the order of performance. See Appendix H.

Learning Activities Specification

The class begins in the affective domain, with a film of Shoreham's only radiation job to date; removing an in-core detector. The trainees are asked to list the tasks performed by the worker and the HP. Then they are asked how they would feel about monitoring themselves in the work area. The DACUM chart was used to focus in on exactly what the HP did - and what the trainee needs to learn to do.

The lesson is in three parts and took from 16 to 24 contact hours, depending on the ability and number of trainees. There were two to six trainees per class, with varying levels of experience. The trainees were asked to recall the source of each hazard, and were shown how to measure it, using the actual equipment. Instrument advantages and limitations were then discussed. A variety of scenarios were presented, allowing the trainees to compare survey results and identify changing conditions. Trainees planned mockup room survey as a group, then performed the survey individually.

Each of the three parts of the lesson follow this format: cognitive concepts followed by demonstration, then guided practice as needed. A final mockup survey was individually planned and executed by each trainee using laboratory job sheets, survey maps, and JPM's. The radiological surveys were performed, with each step measured against its procedural standard. The instructor guided the trainees as required, providing additional demonstration when needed. The mockup rooms are flexible in terms of job simulation. The job sheets directing the lab./mock-up performance were specific to job discipline. For example, radiochemistry technicians collect and transport a sample; mechanics replace valve packing or repair a pump. The lesson's cognitive objectives are separated by type of hazard, radiation, contamination and airborne. The instructional strategies are summarized in Tables 6, 7 and 8. Learning activities correspond to the numbering in Appendix H.

Table 6 Radiation Survey Instructional Strategy Matrix

Learning Activity	Instructional Technique	Media
1a	Lecture/Discussion	TP/Slide
1b	Demonstration/Practice	Equipment (RO-2 Teletector)
2a	Lecture/Discussion	TP/Slide
2b	Demonstration/Practice	Equipment
3a	Lecture/Discussion	Handout (Maps)
3b,c,d 4a,b	Lecture/Discussion	TP/Slide
	Demonstration/Practice	Equipment
5a	Lecture/Calculation	Whiteboard
6a,b	Lecture/Discussion/Practice	TP/Slide, Handout

Table 7 Contamination Survey Instructional Strategy Matrix

Learning Activity	Instructional Technique	Media
1a,b,c	Lecture/Discussion	TP/Slide, Handout
2a,b	Demonstration/Practice	Equipment (Smears, wipes)
3a,b	Demonstration/Practice	Equipment
4a,b	Lecture/Discussion/Practice	TP/Slide, Handout

Table 8 Airborne Survey Instructional Strategy Matrix

Learning Activity	Instructional Technique	Media
1a,b	Lecture/Discussion	TP/Slide
1c	Lecture/Discussion	Whiteboard/Equipment
2a,b	Demonstration/Practice	Equipment
3a,b,c	Demonstration/Practice	Equipment
4a	Demonstration/Practice	Handout

The experienced learners created laboratory scenarios, helped guide slower learners, and critiqued each other's performance using the JPM's. The class concluded with a case study of recent overexposure incidents caused by survey pitfalls.

The instructional activities and media were selected to support Bloom's taxonomy levels. In the affective domain, first with the film, and later with modeling behavior and case study, it is expected that the learner will progress from receiving, through acquiescence in responding. In the cognitive domain, the lesson progresses from the simple knowledge and comprehension levels (lists, definitions) through application (practice) and cognitive domain, the lesson progresses from the simple knowledge and comprehension levels (lists, definitions) through application (practice) and analysis/synthesis (planning, questions) to evaluation in laboratory performance and radiological assessments.

Assessment System Specification

Three courses are required as prerequisites for participating in radiological assessment. The trainees are to be scheduled in advance so that the instructor can verify prerequisite course attendance and successful completion, in lieu of a pre-course test. The instructors are also available for interview. The lesson is in three parts by survey type. Each is followed by progress checks before going on to the next - both performance and written. A post-course test follows the three parts (a comprehensive survey map), and the Job Performance Measures are completed in the laboratory. Mastery of objectives is required (100%), with extra guided practice or instruction provided as needed.

Evaluation System Specification

Systematic evaluation requires both formative and summative techniques. Collecting this data may show a need for additional analysis, design, development, or implementation. These are continuing processes resulting in variable products. Nuclear power plants often change procedures or obtain additional equipment. Training programs continually change. Systematic evaluation is essential.

Formative

Two small group trials were conducted with groups of two. Data from end of course forms and interviews resulted in class/laboratory changes. Delivery of instruction was also evaluated. The lesson plans, progress checks, and laboratory guides were evaluated by LILCO instructional technologists, resulting in modification. LILCO's Office of Training procedures were used for this process.

Summative

The four part Kirkpatrick (1987) method of reaction, learning, behavior and results, was applied. Two levels could be measured. The remaining levels would have to wait for plant operation. LILCO's Office of Training procedures would then be utilized for trainee and supervisor evaluations at three and six months following training.

Learning Transfer System Specification

The commitment of the interdisciplinary DACUM committee helps ensure job relevancy with program ownership. Task validation by plant engineers helps ensure management support. The course material approval process by subject matter experts validates materials. All of these controls help ensure learning transfer and meaning to the organization (Broad, 1982).Classroom/laboratory work is followed by on-the-job training at Shoreham. The same JPM's and procedures are used. . Once qualified, the radiation worker may perform independently from within various job disciplines. For the transfer to be complete, the plant must operate.

Review and Selection of Materials

A slide/tape package on activation and isotopes was selected for use. This is available for trainee review. A "case study" package was purchased from General Physics. The package included a self-study lesson on "hot particles" , "radiation surprises",and "survey pitfalls". These were made available for the accelerated or interested trainee. A case study from "survey pitfalls" was incorporated into the lesson to stimulate discussion , emphasize caution, and the need for accuracy.

Summary

Training needs and DACUM identified tasks with supporting knowledge/skills, led to Job Performance measures to the criterion of Shoreham operating procedures. Learning objectives and evaluation strategies were established. The objectives were grouped according to radiological hazard from the most likely to the least likely to occur. Within each group the objectives were sequenced in order of performance. Learning activities were then matched with instructional technique and media. The evaluation system and learning transfer system were then specified.

CHAPTER 4

DEVELOPMENT

Introduction

Analysis and Design set the *potential* for this project. Development begins "releasing...the energy" (Knowles, 1984). Instructor and student activities create a fusion of energies - the sum total greater than that of the separate parts of analysis and design. Radiation workers will be given challenging opportunities, that have rightfully been theirs all along. The experiential approach will take advantage of the unique potential offered by individuals, interdisciplinary trainees. This will result in greater achievement (Maslow,1970). To measure radiation, to see the needle point, to hear the clicking of the counted pulses in the detector, is to *know* it's there. This project is developed to ensure radiation worker maturation. It is movement from dependency on health physics technicians toward increasing self-directedness (Erickson, 1974).

Learning Activity Development Scheme

In the approval process at Shoreham, first came task verification, then approval of job performance measures (evaluation instruments). The next approval steps were the lesson and laboratory plans with outline of instruction and student/instructor activities. Development centered on the lesson and laboratory plans. The introductory videotape was created during the designer's last health physics quality control surveillance. The case study series had arrived from GP.

Simulation

The focal point of the project is practice for the radiation worker in radiological assessment. This required simulation. Contamination (radioactive dirt and dust) were easily simulated by purchasing Coleman lantern mantels, cutting them up and pasting pieces onto disc smears (paper wafers for wiping surface dust) and air sample filters (fiberglass wafers for collecting dust in the air). Low level radiation fields (5 mRem/hr) and beta dose rates (230 mRem/hr) were provided by depleted uranium slabs.

That left the problem of simulating radiation levels up to 1000 mRem/hr.

The training center purchased a remote control ion chamber simulator ($2800), identical to the RO-2 used at the plant for measuring dose rates. As the trainee performs a survey, the instructor can dial in the dose rates expected during plant operations. As the trainee would get closer and closer to a "hot spot" the dose rates would be increased by the instructor via remote control. When the simulator arrived, the designer spent several hours with another instructor perfecting scale changing and radiation field variations. The first simulator sent worked poorly and had to be replaced. Fortunately, the second one worked according to specifications.

The JPM's and simulator need to be used together for a broad range of abilities. Dr. Jerry Kokalis, Development Supervisor at the training center, provided the designer with a laboratory plan "Directing Trainee Laboratory Experiences," adapted from Directing Student Laboratory Experience, (The Center for Vocational Education, Ohio State University, 1972). The plan uses the self-directed approach, recognizing that it is "neither possible nor desirable to try to keep trainees progressing at the same rate" (Kokalis, 1985).

The designer wrote the lab. plan using job sheets to specify work area and job requirements. A radiation worker permit and survey map were created. The product from the lab would be a completed survey map. The process would be controlled by the three JPM's, one for each hazard or survey type.

In preparing the cognitive portion of the three part lesson, particular care was given to approaching new material using a method of "connected knowing" (Belarsky, M.1986), facilitating objectivity in the sense that trainees can be open to ideas they disagree with. Some may not feel the plant will ever operate; but it may. "Connected knowing" can suspend disbelief and act as if a new idea is true; Shoreham will operate safely in 1989.

Learning Activity Development

INPO requires that nine instructional activities be included in each lesson. These correspond to Gagne's nine events of instruction (1985). Each instructional event stimulates an internal process. See Table 9.

Table 9

Instructional Events with Corresponding Internal Processes

Instructional Event	Internal Process
1. Gaining Attention	Reception
2. Informing learners of the objectives	Expectancy
3. Stimulating recall of prior learning	Retrieval to working memory
4. Presenting the stimulus	Selective Perception
5. Providing "learning guidance"	Semantic Encoding
6. Eliciting Performance	Responding
7. Providing Feedback	Reinforcement
8. Assessing Performance	Retrieval and reinforcement
9. Enhancing Retention and Transfer	Retrieval and Generalization

1. **Gaining attention** - Gaining attention begins with the interdisciplinary work of a dedicated DACUM committee as the foundation of the project. The videotape of replacing an in-core detector at Shoreham introduces and motivates the class. The instructor guides an affective response from trainees.

2. **Informing learners of the objectives** - The learners are informed of the objectives first by presenting the DACUM chart, then handing out the cognitive objectives tied into exactly what the learner will do. The performance objectives are given to the learners during lab. performance.

3. **Stimulating recall of prior learning** - Recall of prior learning is first stimulated by pointing out that most objectives apply knowledge gained from prerequisite courses, then throughout the lesson as these objectives are facilitated.

4. **Presenting the stimulus** - The stimulus is presented first with the illustrated talk in three parts, each containing demonstration followed by practice. The lab. then provided stimuli, followed by a case study of changing conditions.

5. **Providing learner guidance** - Learner guidance is provided first

with questioning technique then modeling performance of radiological surveys. Guided practice is provided in the lab. and later at the plant as part of OJT.

6. **Eliciting performance** - Performance is elicited both in product (completed radiological survey maps) and process (JPM guided labs.). This is followed by OJT performed by plant OJT trained trainers.

7. **Providing feedback** - Positive reinforcement is provided throughout the lesson, encouraging, stimulating, and facilitating. The completed maps are reviewed, each DACUM identified critical step is initialed when performance to the standard of the JPM is attained.

8. **Assessing performance** - A brief progress test follows each part of the lesson; mastery is required. The completed lab survey map is graded and JPM's must be performed to criteria.

9. **Enhancing retention and transfer** - The DACUM process ensures relevancy. The case studies allow for exploration of operating plant problems. Immediate application at Shoreham (although limited until operation) with OJT, along with qualification by health physics supervisor, transfers the learned skills. **Lesson Plan**

LILCO's Office of Training procedure was followed when developing the illustrated talk/demonstration/practice lesson. It consists of a cover sheet followed by lesson data pages containing:

- Objectives (31)
- Job position (Radiation Worker)
- Tasks (3)
- Setting (Classroom/laboratory)
- Duration (Range of 8 to 16 hours)
- Instructional Materials
- Student Materials
- References

The six data pages are followed by fourteen two-column pages. The left column is the outline of instruction paralleled on the right by instructional activities (student and instructor). The progress tests are attached to the lesson plan. See Appendix J.

Laboratory Plan

During the lesson the three radiological assessment tasks were demonstrated, and the trainees were guided in practice in the laboratory. Each task, for simplicity, was treated separately. In the laboratory plan, the three parts of radiological assessment are treated as one job. Laboratory and mock-up rooms will be used for different scenarios, depending on radiation worker discipline. The first scenario was to set up a mock-up tank room where radiochemistry technicians are to perform radiological assessments prior to drawing a sample - independently. The training center has a compressor room with a large tank in the corner and 2 large air compressors. The room is just like a typical tank room. The laboratory plan contains:

- Job Sheet (Specific to worker discipline)
- Job Planning Format (For accelerated worker)
- Information Sheets (Survey maps)
- Job Performance Measures (3)
- Radiation Work Permit

The duration of the lab. will be from two to eight hours, depending on the need for additional practice. The laboratory plan is in Appendix K.

Learning Activity Review

Verbal technical approvals were received from the plant radiochemistry and health physics engineers. The NRC readiness assessment activities delayed the formal technical approval process for lesson and lab. plans. The instructional adequacy reviews for the lesson plan and lab. were conducted by two instructional technologists at the training center. Copy editing was performed by the word processing pool at the J.W. Dye, Jr. Training Center.

The designer and program development supervisor edited all completed materials to ensure that the products were responsive to the design. The GET 1 and 2 instructors were asked to review the completed materials, in addition to the instructional technologists already mentioned.

Materials for Evaluation Produced

Two radiochemistry technicians were selected for the first trial. The plant was not able to provide more members of the target audience. Two complete sets of instructional materials were produced. One additional two member trials was scheduled a week later, allowing time for revisions.

Summary

Progressing from the training plan of the design phase, development specifies learning activities and creates training methods and materials. The cognitive focus for the radiation worker was a three-part lesson plan supporting radiation, contamination and airborne surveys. This was followed immediately by laboratory simulation with practice in radiological assessment.

CHAPTER 5

IMPLEMENTATION

Introduction

The products to be implemented include lesson and lab plans, videotape of in-core detector removal, case study, student text and transparencies. Tryout results provided some revisions. The radiation worker training plan is activated, and students are scheduled. The training will be delivered as specified at the J.W.Dye, Jr. Training Center. In-training evaluation will be conducted on both instructor and materials. LILCO's Office of Training procedures will be used for maintaining training records. The potential energy of analysis and design began releasing in development. Now in implementation, everything becomes kinetic energy. Note: something in motion will tend to stay in motion. (Sir Issac Newton)

Materials for Implementation Reproduced

After revisions to materials were completed, three copies were produced (one for the designer, also the facilitator for the training plan; one for the record in the secure file room at the center; and one for the program evaluator, a subject matter expert and senior instructor). Six copies of the student handouts were made for the scheduled six students. Student handouts may be found in Appendix L.

Instructional Delivery

Six students were scheduled for the first class beginning Monday, March 20. Four were contractor technicians and two were radiochemistry staff technicians. The individual desks and chairs were placed in an opened "U." At the open end, in front of the class, was the white board; 45 degrees to the left side was the screen for projecting slides/transparencies; 45 degrees to the right side was the television/VCR. As students entered the door at the rear of the classroom, they saw these words on a flipchart:

Learning is a cooperative process

- The class needs your active participation, and members need your respect.
- Questions are important. Please ask them.
- Breaks will be taken whenever needed, frequently.
- Morning donuts and coffee and afternoon fruit are provided for relaxed discussion; lunch is 12 to 1.

Coffee and donuts were on the table beside the flipchart. The equipment for the lesson was laid out on the laboratory table tops.

The four contract technicians did not have Navy nuclear experience. The designer/facilitator found it necessary to show the "Ionizing

Radiation" slide/tape presentation from NSS. While doing this (approximately one hour), the two staff trainees were asked to design a radiation exercise scenario using the "job planning format." The scenario turned out to be so well received that the designer included it in the laboratory plan. See Appendix M.

The radiation survey portion of the lesson took five hours, an hour longer than expected. The contamination portion took two hours and ended the first day. The second day began with airborne surveys. The red ball flow indicator on the Radeco air sampler did not bounce with the flow variation, so it had to be used in high velocity only. The flow read in liters/minute. The staff technicians pointed out that the plant's sampler read in cubic feet/minute. The designer taped a cardboard scale over the one on the air sampler.

Due to the momentum of the class, a survey brainstorm exercise and case study were postponed until after the comprehensive laboratory. This worked well as a simulation and survey review. The designer decided it was more effective to discuss problems after the trainees had experienced problems during the laboratory.

The comprehensive laboratory was completed the second day. During lab performance, the air compressor turning on and off increased the noise level to that similar to a subway station. This added a note of realism and required the addition of ear protection to the lab requirements. The designer dumped a bucket of water on the floor under the tank to add more realism. At the end of the survey the designer set off a continuous air monitor alarm to indicate the most likely changing radiological condition the trainee would be exposed to; that of airborne radioactivity resulting from a leak, or stirred up contamination. The trainees responded very positively to this realism; they gladly left the area!

The third and final day contained the survey pitfalls brainstorm followed by case study. The trainees were interested enough to want to read the GP case studies of "radiation surprises." No one showed any interest in the GP "hot particle" case study. None of the contract technicians had been at an operating nuclear power plant that had the problem of fuel fleas. In discussing this with the plant's engineers, it was decided to treat "hot particles" as a special case, to be taught only in the event of fuel failure.

Data Collection

LILCO's Office of Training end of program comment form was used to measure student reaction to the class/laboratory (Kirkpatrick, 1987). The form consists of three pages and solicits opinions on student materials and instructional technique. See Appendix O. The trainees were also invited to make recommendations for change. Each class had three progress tests serving as a measure of learning (Appendix I), in addition to completed radiological survey maps. Completed and initialed JPM's (Appendix G) measured each class's performance. A range of 16 to 24 hours was allowed for the project. The first trial was 16 hours and the second 20 hours. The first class of six was 24 hours.

Summary

The radiation worker training plan was implemented and training delivered. The lesson plans, laboratory guide, student handouts, and progress checks were all reproduced, utilized and data collected. The radiological assessment training ranged from 16 to 24 hours. Implementation resulted in ten trained radiation workers.

CHAPTER 6

EVALUATION

Introduction

In the age of accountability and information, there is no substitute for empirical data. That is the thrust of this chapter; when to collect it and what to do with it. The radiological assessment program tryouts resulted in several changes. Formative evaluation, one-on-one and small group trials showed a need to eliminate some materials, and to add other material. While still formulating the program, the designer wanted the pilot test to be formative. However, the radiochemistry engineer wanted to accelerate the schedule and begin his second quarter continuing training cycle in March rather than April. This is where formative met summative, in class on March 20, 1989.

Formative Evaluation

Instruction is a dynamic process, ever subject to revision and improvement, especially in the early stages of one-on-one small group trials and field pilot tests.

One-on-One Trials

A trainee from the target audience was not available for one-on-one trials. A fellow senior instructor who was a member of that audience two years ago, evaluated the lesson materials and the facilitator during the laboratory tryout. See Appendix N. He suggested that the fill-in student handout was more distracting than helpful. It was removed from the program.

Small Group Trials

Two small group trials were conducted; each had two trainees from the target audience. The four trainees filled out the "program comment form" used at the J.W. Dye, Jr. Training Center. Their comments are summarized in Appendix O. An instructional technologist collected the forms, insuring anonymity. He followed up with questions on the usefulness of the training. Three of the four were positive, the fourth felt it would only "beef up" his resume in the event Shoreham closed.

Due to the small size of the tryouts, the three progress tests were given orally to allow the trainees to demonstrate the degree to which they had mastered the objectives; the minimum criteria being the same as that of the written test. One of the four trainees simply did not feel he would ever be called on to perform the tasks selected for training. Three felt that more examples of completed surveys would be helpful, particularly in identifying changing conditions from one survey to the next.

Pilot Test

The test group consisted of six trainees who were very cooperative; all achieved mastery of the objectives. Their end of program comment forms are summarized in Appendix P. The progress tests were written and followed by additional instruction for the contract technicians, while the other students planned a lab scenario.

The designer's "instructor end of course form" showed a need to include the NSS slide/tape summary of activation products, using only the isotopes expected at Shoreham. This was necessary to more fully understand the sources of contamination, hot spots, and radiation. The facilitator also found the debate on posting to be ineffective. There was nothing to debate. See Appendix Q.

Three of the six trainees felt that an additional comprehensive lab scenario would improve the program. Since on-the-job training would include additional practice before qualification, another scenario (job sheet) was not developed. The one scenario, for the simulated tank room, was expanded to include changing conditions. Moderate and high contamination were added. Table 10 summarizes the revisions of the evaluation events.

Table 10

Program Revisions

Problem	Revision
1. Remedial or additional training needed for activation products and hot spotsl	Slide/tape added to lesson.
2. Debate exercise on posting ineffective.	Removed from lesson.
3. Case Study at the end of the lesson plan disrupted momentum of class.	Moved to end of lab.
4. Need more data prior to brainstorm	Add NRC violation of missed exercise.
5. Compressor noise in lab.	Require ear protection on RWP.
6. Student fill-in handout distracting.	Removed from lesson.

Summative Evaluation

Summative evaluations make it possible to determine how well the instruction has worked (Gagne', 1984). Additionally, the evaluation will show whether Shoreham should adopt the continued use of the designed instruction. A method for answering these questions is found in the four measurable levels of reaction, learning, behavior and results (Kirkpatrick, 1987) as found in Table 11.

Table 11

Levels of Evaluation and Measurement

Level	Importance	Method of Measurement
1. Trainee reaction or acceptance	4	Questionnaire and interview by IT
2. Learning or gain in knowledge or skill	3	Progress tests, survey maps, and JPM's
3. Job performance or behavior improvement	2	Supervisor and trainee rating questionnaire & interviews
4. Overall results goals	1	Management records/savings

Reaction

On the way to the ultimate level of evaluation, that of results, is the first level of trainee reaction. LILCO's Office of Training "program comment form" is presented to the class, and then summarized by an instructional technologist. Since Shoreham is not operational, job performance and overall results are not available. For this reason, far too much emphasis is placed on reaction results. The results of the first class of six trainees are summarized in Appendix P. The instructor's reaction is also required for a more meaningful evaluation.
See Appendix Q.

Expectations were high, and so were the measured reactions. The forms are optional and kept anonymous. A 100% return was realized. The consensus wanted more lab time with more scenarios. The plant could not provide the additional training time, although the engineers do want to keep the lab as an annual continuing training requirement. The use of the laboratory will vary with plant operations.

Learning

Positive reaction does not measure learning. The three progress tests and completed survey maps do measure learning. Short essay questions and the completed survey maps ensured mastery of all the objectives. Additional training was provided as needed. The plant agreed that a radiation worker who does not achieve mastery will not act independently.

The higher cognitive levels of synthesis, analysis and evaluation need to be achieved in order to identify changing conditions and eliminate overexposure while minimizing exposure. The classes were also limited to six. It is for these reasons that short essay questions and completed survey maps are used to measure mastery, as the lesson progresses. All of the radiochemistry technicians, the pilot group, achieved mastery and demonstrated learning. During the laboratory or workshop practice, each step of the job performance measures were completed in order. Both process (JPM) and product (map) were completed successfully. Training was deliverd as shown in Table 12.

Table 12

Training Deliverd

No. of Trainees	Learning Group
2	Small Group Trial
2	Small Group Trial
6	Pilot Test

Behavior

In keeping with Kirkpatrick, behavior will be measured by the trainee and the trainee's supervisor. LILCO's three and six month evaluation forms will be used. In the past they have been sent to the plant even though they are not yet operational. This may explain part of the reason for a very low return rate. The data for this program will be useful only under operational conditions. These forms are included in Appendix R. The tasks trained are identified so that the trainee and supervisor can provide feedback as to whether the trainee behavior changed based on what was learned.

Results/Impact

According to Kirkpatrick, this is the most important level of evaluation. It is here that results are related to organizational improvement including cost surveys and work output.

The cost of the program, including training the pilot group of radiochemistry technicians, is approximately $50,000. Next would follow training of the I and C technicians, and then the mechanics. Contractors would be trained as they arrived to begin outage work. The additional cost would be the cost of labor for a three day period.

During an outage, health physics contractors can be reduced by 50 percent. This would mean that instead of 80, only 40 would be needed, at a cost of approximately $50 per hour. This savings would more than pay for the program. The additional training would also minimize dose, and it is expected that any potential overexposure incident would be averted. This saving is incalculable.

Overall results are also measured by the NRC and INPO. Shoreham's programs will be compared to those of other operating plants, including statistics on collective dose savings as well as observations of radiation worker performance in radiation areas. These results are generally reported by the media, including the national ranking of the plant.

Learning Transfer

LILCO's Office of Training and Shoreham have a good working relationship that has resulted in INPO certification of all their nuclear related programs. This program for the radiation worker requires an interdisciplinary management commitment.

Each department recognizes that dose control is everyone's responsibility. The radiological assessment skills training program provides another means for acting on that responsibility. The interdisciplinary Station ALARA Committee (SAC) meets regularly to review jobs in radiation areas. Part of their review could include new lab simulations, job performance feedback, and management dose control goals, and other data from INPO and NRC surveillances. Action items could then come from the managers down to the supervisors. This committee could provide the "management actions to support transfer of training to the job" (Broad, 1982). Three actions include:

- Participate in preview of training and briefing
- Issue statement on new performance levels for the radiation worker
- Require attendance at training and meet with trainees to discuss ways to apply new behaviors

Summary

A one-on-one trial, two small group trials, and pilot test resulted in formative changes. The pilot test was also the first class used for summative evaluation. All of Shoreham's radiochemistry technicians mastered the objectives. This will be the first radiation worker group to provide job performance data and cost results, when the plant is fully operational.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

Introduction

The chapter is the summary of this project; a new program on radiological assessment. It was designed by and for radiation workers at the Shoreham Nuclear Power Station. The designer/facilitator draws conclusions and makes recommendations for others interested in applied health physics at operating nuclear power plants.

Methods and Procedures Used

The method is the Training System Design, managed by the Institute for Nuclear Power Operations. The end product meets the TSD criteria. The process also involves LILCO's Shoreham and Office of Training procedures. The setting is the J.W. Dye, Jr. Training Center in Central Islip, New York. The five familiar components of analysis, design, development, implementation and evaluation will be summarized in terms of inputs and outputs.

Analysis

Shoreham preoperational readiness assessment identified potential performance problems. A DACUM Committee of several job incumbents working in the duty area of "independent radiological assessment" identified four tasks necessary for radiation worker independence in low level radiation areas. Inputs from the needs analysis included:

- Potential job performance problems
- Anticipated radiation worker resource requirements

Job and task analysis with the DACUM Committee resulted in:

- Tasks selected for training
- Identified knowledge and skills selected for training

Use of the interdisciplinary DACUM Committee established job incumbent ownership in the program. Assumptions, limitations and prerequisites were established. A literature review was performed as well as a review of existing materials. A budget was established and Gantt chart created.

Design

With inputs from analysis, job performance measures were constructed to measure trainee performance on each task selected for training. Objectives to measure what, when and how well, were written and higher cognitive level progress tests were produced. The objectives were grouped according to likelihood of hazard and sequenced in the order of performance required by Shoreham's operating procedures. The training plan was written with the following outputs:

- Job performance measures
- Learning objectives
- Progress checks for mastery
- Training setting of classroom/laboratory

Development

The instructional events were identified using Gagne's nine steps. The strategies were matched to the objectives. Usable training materials were identified and lesson and laboratory plans were written. Training tryouts were conducted and revisions made. The outputs were:

- Training materials
- Lesson plan in three parts
- Laboratory plan
- Tryout revisions

Implementation

Training was delivered to the first class of six radiochemistry technicians. The training was documented and in-training evaluation data collected and summarized. The outputs were:

- Six trained radiation workers
- In-training evaluation collection
- Training documented

Evaluation

Formative evaluation included a one-on-one trial and two small group trials. Some material was eliminated and some added. The pilot test became both formative and summative. Two Kirkpatrick levels were measured, but results would have to wait for plant operation. The output:

- Training performance data applied to program information
- Projected improvement in worker performance
- Projected lower dose cost
- Projected cost savings

Conclusions

In the age of information overload, criterion referenced training helps manage the load. The problem for the radiation worker at Shoreham is lack of practice in applying learning about radiological conditions.

Learning seems to quickly fade to a game of trivial pursuit, pieces of unconnected information. This project has stressed higher cognitive level mastery, putting the pieces together, then using the knowledge and new skills in an organized performance; but it is still simulation with plant operational status uncertain. If the radiation worker can "...be content to begin with doubts, he shall end in certainties." -Francis Bacon, *The Advancement of Learning.*

Recommendations

These recommendations evolved from the conclusion that learning which is not immediately applied results only in a fading recollection of pieces of information. This is an acute problem for the Shoreham radiation worker. The following recommendations are essential for continuing the project as plant *operational* training:

1. The most important recommendation involves a problem in "job linkage" (Broad, 1982). Training at the center concluded with the comprehensive lab. This needs to be followed immediately by on-the-job training, practice under supervision, and then qualification by supervisory personnel. An OJT guide has been submitted to the engineers involved to stimulate the linkage process. See Appendix S.

2. In the area of training "follow-up" (Broad, 1982), assuming Shoreham is operational, direct observation of training effectiveness will be needed. The facilitator/subject matter expert (SME) should directly observe trainee task performance and provide behavior measures. This will provide another avenue for maintaining course materials while at the same time helping the instructor stay current. At the plant, QA surveillances and audits can be reviewed for possible problem solving training, after discussions with the involved engineers. This approach can

be patterned after the Performance Evaluation of Training Effectiveness (PETE) presented at the proceedings of the Seventh Symposium on Training Nuclear Facility Personnel (Orlando, FL., 1987). See Appendix T.

3. An additional "follow-up" recommendation is to "provide occasional practice sessions for important but seldom used skills" (Broad, 1982). Until Shoreham operates there will be many skills to practice, and practice again. Laboratory practice can be provided quarterly with continuing training.

4. This program is unique to Shoreham, and owned by the DACUM Committee. However, a similarly developed program could be applied to any operating nuclear plant with INPO accredited training. The JPM's are plant specific, although the task analysis would probably be similar. Certainly more extensive use of laboratory/workshop simulation could only benefit the industry. More attention should be focused on job linkage and follow-up. Collective person-REM (dose savings) would be reduced even more. See Appendix U.

Concluding Statement

This project began with the "plausible impossibility" of Shoreham becoming operational. Certainly this seemed to be preferable to the high probability of blackouts in the summer of 1989 and 1990. Performance based training continued at Shoreham in anticipation of plant operations and eventual performance. The focus of this project has been the radiation worker and hazard identification. Laboratory simulation and practice were clearly the method of choice, as long as the "plausible impossibility" remained.

"When you have eliminated the impossible, whatever remains, however

improbable, must be the truth."

-Sir Arthur Conan Doyle

The Sign of Four

APPENDIX A

RADIATION WORKER QUESTIONNAIRE

RADIATION WORKER QUESTIONNAIRE

QUESTION	CORRECT ANSWERS	INCORRECT ANSWERS	PERCENT CORRECT
1. Do you know your dosimeter reading?	35	3	92
2. When is the last time you read your dosimeter?	32	6	84
3. At what level dosimeter reading will you leave the Radiation Control Area (RCA)?	28	10	74
4. Do you know the administrative dose guidelines?	13	25	34
5. Do you know the NRC legal dose limits?	10	28	26
6. Do you know what the requirements are for an RWP?	5	33	13
7. What does ALARA stand for?	38	0	100
8. Do you know your margin?	16	22	42
9. What is a contaminated area?	9	29	24
10. What would you do if you heard a radiation area alarm?	38	0	100
11. What would you do if you alarmed a frisker?	37	1	97
12. Do health physics technicians have the authority to stop work?	38	0	100
13. Who is responsible for your exposure?	38	0	100
14. What should you do if you discover your dosimeter (TLD) missing?	35	3	92
15. What are the requirements for wearing a respirator?	33	5	86
16. What is a high radiation area?	18	16	53
17. What is a radiation area?	9	25	26

APPENDIX B

DACUM CHART

	TASKS	PERFORMANCE STEPS					
A	PERFORM A RADIATION SURVEY	SELECT DOSE RATE METER	PERFORM PREOPERATIONAL CHECKS	OBTAIN GENERAL AREA DOSE RATES	OBTAIN CONTACT DOSE RATES	OBTAIN BETA DOSE RATES	COMPLETE A RADIATION SURVEY MAP
B	PERFORM A CONTAMINATION SURVEY	DETERMINE METHOD	PREPARE SMEARS AND WIPES	OBTAIN CONTAMINATION SAMPLES	COMPLETE A CONTAMINATION SURVEY MAP		
C	OBTAIN AN AIR SAMPLE	SELECT AIR SAMPLER	PREPARE SAMPLER	OBTAIN AIRBORNE SAMPLE	COMPLETE AN AIRBORNE SURVEY MAP		
D	IDENTIFY CHANGING CONDITIONS	IDENTIFY POTENTIAL CRUD TRAPS	IDENTIFY HOT PARTICLE POTENTIAL	PLAN FOR RADIOLOGICAL CHANGES	RESPOND TO RADIOLOGICAL CHANGES		

APPENDIX C

ANALYSIS OF VERIFIED TASK

ANALYSIS OF VERIFIED TASK

Radiation Worker

TASK A: PERFORM A RADIATION SURVEY

In performing this task, the radiation worker will:

COMPLETE THESE STEPS	KNOW THE FOLLOWING
1. Select dose rate meter	Instruments available, scales and ranges. *Operation of ion chamber. Expected dose rates. *How to read survey map. Teletector ALARA capability.
2. Perform preoperational checks	Distance to source. Number of batteries. Zero check for ion chamber. Source reading within ±20% Physical checks, beta window. *Need for current calibration. *Meter response time.
3. Obtain general area dose rates	*Definition of general area *How to minimize exposure. General area levels on survey map. Scale selection for readings. Readings taken at waist level. How to protect instrument. When to use head&knee readings.
4. Obtain contact dose rates	Definition of contact reading. How to compare contact and general area. Need for component contact readings. Definition of "hot spot." *Gamma interaction with matter. *Gamma sources. ALARA considerations.
5. Obtain beta dose rates	*Definition of beta dose rate. Need for beta correction factor. Need for closed window reading. Need for open window reading. How to calculate beta level. *Beta interaction with matter. *Need for beta protection. *Beta sources.

*Prerequisite training

ANALYSIS OF VERIFIED TASK
Radiation Worker

TASK B: PERFORM A CONTAMINATION SURVEY

In performing this task, the radiation worker will:

COMPLETE THESE STEPS	KNOW THE FOLLOWING
1. Determine method	Comparison of quantitative and qualitative. When to use a smear. When to use a wipe. Comparison of fixed and loose contamination. *Definition of contamination. *Sources of contamination.
2. Prepare smears and wipes	Media for qualitative. Media for quantitative. Area limitations. Sample control. Pre-numbering and planning. Comparison of media.
3. Obtain contamination samples	Prevention of cross contamination. Pressure to be applied. The "S" technique. Gross measure vs. qualitative. What to smear or wipe.

* Prerequisite training

ANALYSIS OF VERIFIED TASK
Radiation Worker

TASK C: OBTAIN AN AIRBORNE SAMPLE

In performing this task, the radiation worker will:

COMPLETE THESE STEPS	KNOW THE FOLLOWING
1.Select air sampler	*Sources of airborne radioactivity. Causes of airborne. Types of airborne. Air samplers available. How to match sampler to sampling. Necessity of calibration. Reason for sampling.
2. Prepare the sampler	How to select and install filters. Filter types and use. Importance of filter position. Filter efficiency. *Prevention of cross contamination.
3. Obtain airborne sample	How to obtain sample. Comparison of iodine, particulate and gas sampling. Minimum volume. Sampler positioning. *Definition of airborne. *Use of MPC concept. Definition of breathing zone. Comparison of BZ and GA sample. Reason for sampling. ALARA considerations.

* Prerequisite training

ANALYSIS OF VERIFIED TASK
Radiation Worker

TASK D: IDENTIFY AND RESPOND TO CHANGING CONDITIONS

In performing this task, the radiation worker will:

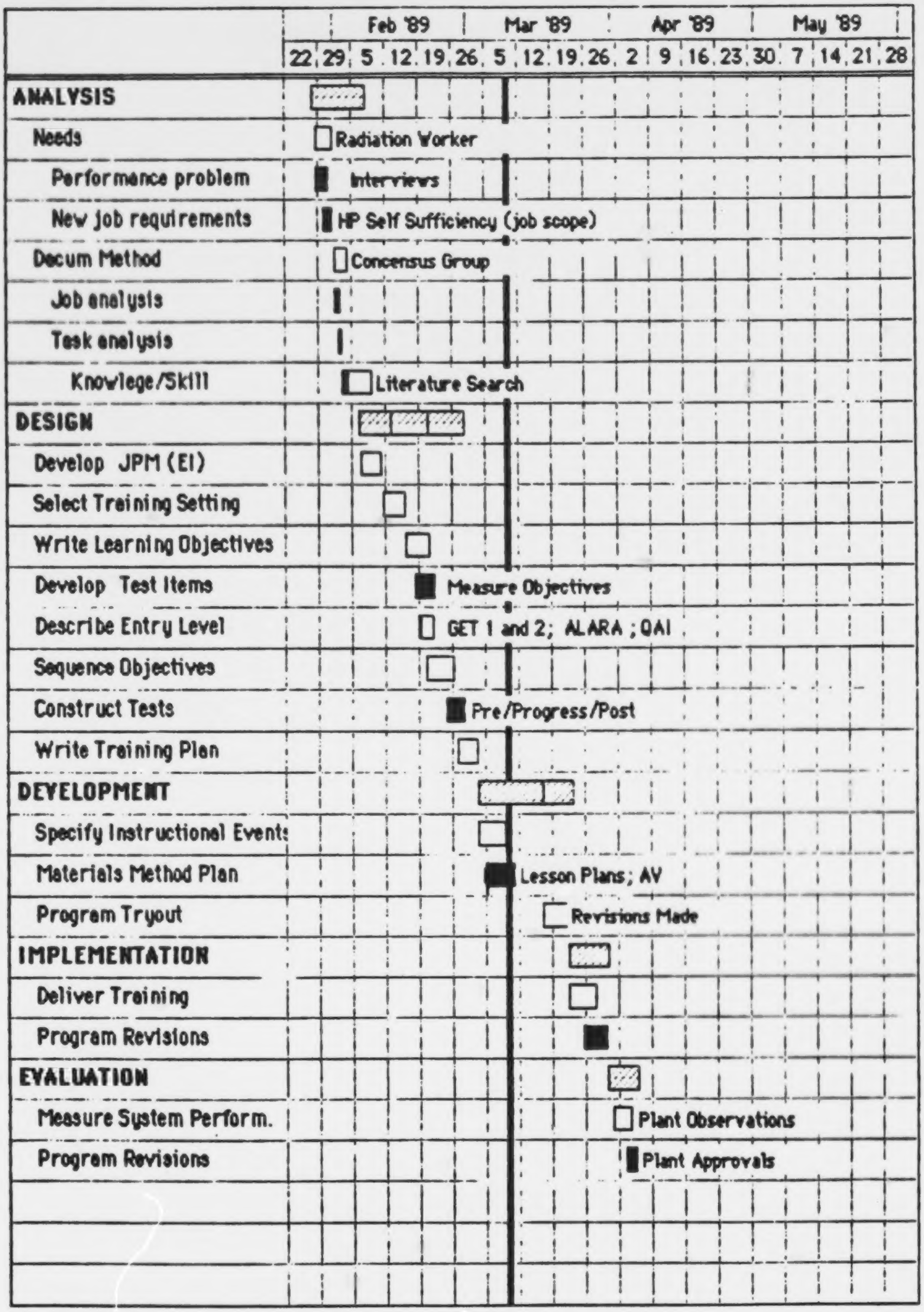
COMPLETE THESE STEPS	KNOW THE FOLLOWING
1. Identify CRUD traps	*Activation of metal oxides. Low flow locations. Piping bends. Possibility of CRUD bursts. Connection with hot spots. Potential for change.
2. Identify hot particles	Activation of stellite particles. Identification of fuel fleas. Isotopes found in hot particles or fleas. Comparison of particles to fleas. Relationship to fuel failure. Potential for change.
3. Plan for radiological changes	Role of activation. *Neutron reaction with matter. History of radiation surprises. Overexposure incidents. *ALARA formal review.
4. Response to radiological changes	*Role of RWP control. *HP hold points. *Alarming conditions. Definition of Significant change. When to exit work area. When to inform HP. ALARA considerations.

* Prerequisite training

APPENDIX D

GANTT CHART: RADIATION WORKER PROJECT

Radiation Worker Project



APPENDIX E

RADIATION WORKER PROJECT BUDGET

RADIATION WORKER PROJECT BUDGET

PHASE	LABOR COST DESIGNER/SME	OTHER LABOR COST	COST OF MATERIALS	SUB TOTALS
ANALYSIS	10 days 80 hrs x $70 $5,600	DACUM: 6 job incumbents 48 hrs x $20.83 $1,000		$6,600
DESIGN	21 days 168 hrs x $70 $11,760	Instructional Technologist review $320		$18,680
DEVELOPMENT	19 days 152 hrs x $70 $10,640	4 technician tryouts 96 hrs x $25 $2,400	simulator $2800 General Physics material: $5,000	$39,520
IMPLEMENTATION	9 days 72 hrs x $70 $5,040	6 technicians pilot 144 hrs x $25 $3,600		$48,160
EVALUATION	6 days 48 hrs x $70 $3,360	Instructional Technologist review & evaluation $320		$51,840

APPENDIX F

TASK ANALYSIS WORK SHEETS

TASK ANALYSIS WORKSHEET

Radiation Worker

Task Number: HRT-01-01

Date:3/08/89	Long Island Lighting Co.	Analyst: Engel

TASK TITLE

Perform a radiation survey

CONDITIONS

Given a radiation area work assignment with specific radiation work permit and a health physics pre-job briefing

STANDARDS

To the standard of SNPS operating procedures as outlined

MATERIALS/TOOLS/REFERENCES/EQUIPMENT

Eberline RO-2, Teletector, survey maps, check source, plastic bags

SP 61.080.01- SP 62.010.01- SP 63.010.03- SP 63.010.05-

INITIATING CUE(s)

Assigned work in a radiation area

TERMINATING CUE(s)

Work completed

CONSEQUENCES OF INADEQUATE PERFORMANCE

Potential overdose with statistical increase in cancer risk

PERSONNEL SAFETY CONSIDERATIONS

Exercise caution and maintain dose as low as reasonably achievable

Be alert to changing conditions

COMMENTS

Performance steps are to be completed in numerical order

Reviewed by: ____________ Date: ________ Position: ____________

Reviewed by: ____________ Date: ________ Position: ____________

Reviewed by: ____________ Date: ________ Position: ____________

Approved by: ____________ Date: ________ Position: ____________

TASK ANALYSIS WORKSHEET

Radiation Worker

Task Number: HRT-01-02

Page 1

Date:3/08/89	**Long Island Lighting Co.**	**Analyst: Engel**

TASK TITLE Perform a contamination survey
CONDITIONS Given a contaminated area work assignment with specific RWP and health physics pre-job briefing
STANDARDS To the standard of SNPS operating procedures as outlined
EMATERIALS/TOOLS/REFERENCES/EQUIPMENT Box of disc smears and masslin wipes, map for work area, plastic bags SP 62.020.01- SP 62.010.01-
INITIATING CUE(s) Assigned work in a contaminated area.
TERMINATING CUE(s) Completion of work.
CONSEQUENCES OF INADEQUATE PERFORMANCE Potential uptake
PERSONNEL SAFETY CONSIDERATIONS Be alert for potential airborne
COMMENTS Any welding, grinding, or cutting may produce more contamination and potential airborne. Use of pneumatic tools may also create airborne.

Reviewed by: ____________________ **Date:** __________ **Position:** ______________

Reviewed by: ____________________ **Date:** __________ **Position:** ______________

Reviewed by: ____________________ **Date:** __________ **Position:** ______________

Approved by: ____________________ **Date:** __________ **Position:** ______________

TASK ANALYSIS WORKSHEET

Radiation Worker

Task Number: NRT-01-03

Date:3/08/89	Long Island Lighting Co.	Analyst: Engel

TASK TITLE

Perform an airborne survey

CONDITIONS

Given an airborne area work assignment (potential) with specific RWP and health physics pre-job briefing.

STANDARDS

To the standard of SNPS operating procedures as outlined

MATERIALS/TOOLS/REFERENCES/EQUIPMENT/etc.

Portable air samplers (Radeco, Ras-1), particulate filters, charcoal filters, and plastic bags.

SP 62.010.01- SP 62.030.01- SP 63.032.01-

INITIATING CUE(s)

Assigned work in an airborne area (actual or potential).

TERMINATING CUE(s)

Completion of work

CONSEQUENCES OF INADEQUATE PERFORMANCE

Radioactive body burden

PERSONNEL SAFETY CONSIDERATIONS

Potential uptake

COMMENTS

Airborne samples are taken when any contaminated system is opened or when contamination levels reach 50,000dpm/100sq.cm.

Reviewed by: ____________________ Date: __________ Position: ______________

Reviewed by: ____________________ Date: __________ Position: ______________

Reviewed by: ____________________ Date: __________ Position: ______________

Approved by: ____________________ Date: __________ Position: ______________

APPENDIX G

JOB PERFORMANCE MEASURES

JOB PERFORMANCE MEASURE

Radiation Worker

Task Number: HRT-01-01

TASK

Perform a radiation survey

CONDITIONS UNDER WHICH TASK IS TO BE PERFORMED

Given a radiation area work assignment with specific radiation work permit and a health physics pre-job briefing

HOW WELL THE TASK HAS TO BE PERFORMED

To the standard of SNPS operating procedures as outlined

MATERIALS/TOOLS/REFERENCES YOU MUST OBTAIN

Eberline RO-2, Teletector, survey maps, check source, plastic bags

SP 61.080.01 SP 62.010.01 SP 63.010.03 SP 63.010.05

WHAT SHOULD PROMPT YOU TO PERFORM THIS TASK

Assigned work in a radiation area

PROCESS OF GRADING PERFORMANCE

1. Failure of a critical step constitutes failure of the task.
2. All critical steps must be performed in order.

Trainee: ____________ Date: ________ Position: ____________

Signature: ____________ Social Security Number: ____________

Evaluator: ____________ Date: ________ Position: ____________

Signature: ____________

STEP #	DESCRIPTION		C.E.	COMPLETED
1.0	Select a dose rate meter		C	
1.1	Review prior survey data	Compare expected dose rates to RWP Surveys in RWP folders		
1.2	Determine the type of meter to use	Ion chamber scale range to meet expected range for work area Teletector for high range(hot spot)		
2.0	Perform the preoperational checks		C	
2.1	Check the calibration sticker	Current and legible Teletector tagged		
2.2	Check the physical condition	Detector window free from puncture Meter operational		
2.3	Check battery(s)	Meter shows "OK" range for each		
2.4	Check meter zero	Selector switch on zero Meter adjusted to hairline		
2.5	Source check	Detector to source=0.5in Allow meter to stabalize 5 to 12sec Response ± 20%		
3.0	Obtain general area dose rates		C	
3.1	Wrap meter	Protect from contamination Tape for easy removal		
3.2	Select meter scale for area entry	One scale higher than expected Highest scale if dose rate unknown		
3.3	Establish initial dose rates	Use good ALARA practices First readings at doorway Use shielding Identify expected sources		
3.4	Obtain general area dose rates	Readings taken only in accessible areas at least 18in from any source		
3.5	Obtain dose rates at closest whole body position	Generally at waist level Sources overhead at head level Sources underfoot at knee level		
3.6	Document results on survey map	Underline radiation levels Record to the nearest mRem/hr Use standard symbols		
4.0	Obtain contact dose rates		C	
4.1	Identify components	Follow increasing reading to source Only components that are accessible		
4.2	Position detector	Within 0.5in from source Then 18in from source		
4.3	Identify hot spots	Contact reading >4XGA and >100mR/hr Spot is usually labelled		

STEP #	DESCRIPTION		C.E.	COMPLETED
5.0	Obtain beta dose rates		C	
5.1	Identify components	Open contaminated systems in the vicinity of worker hand-eye locations		
5.2	Check meter	Detector has beta window Beta correction factor determined		
5.3	Obtain open window dose rate	To the nearest mRad/hr Detector within 0.5in from source		
5.4	Obtain closed window dose rate	Same distance from source To the nearest mR/hr		
5.5	Calculate beta dose rate	Subtract OW-CW and multiply by BCF Units in mRad/hr Record data on survey map		

JOB PERFORMANCE MEASURE

Radiation Worker

Task Number: HRT-01-02

TASK

Perform a contamination survey

CONDITIONS UNDER WHICH TASK IS TO BE PERFORMED

Given a contaminated area work assignment with specific RWP and health physics pre-job briefing

HOW WELL THE TASK HAS TO BE PERFORMED

To the standard of SNPS operating procedures as outlined

MATERIALS/TOOLS/REFERENCES YOU MUST OBTAIN

Box of disc smears and masslin wipes, map for work area, plastic bags

SP 62.020.01 SP 62.010.01

WHAT SHOULD PROMPT YOU TO PERFORM THIS TASK

Assigned work in a contaminated area.

PROCESS OF GRADING PERFORMANCE

1. Failure of a critical step constitutes failure of the task.
2. All critical steps must be performed in order.

Trainee: ______________________ Date: __________ Position: _______________

Signature: ______________________ Social Security Number: ____________________

Evaluator: ______________________ Date: __________ Position: _______________

Signature: ______________________

Task Number: HRT-01-02

STEP #	DESCRIPTION		C.E.	COMPLETED
1.0	Determine the survey method		C	
1.1	Select qualitative (masslin)	To verify the prescence or spread of contamination.		
1.2	Select quantitative (disc)	To quantify area of known contamination.		
2.0	Prepare disc smears and masslin wipes		C	
2.1	Prepare wipes	Fold in quarters Number plastic bags		o
2.2	Prepare smears	Number discs Staple open folds		
2.3	Prepare survey map	Mark smear locations with circled numbers, and wipe locations with numbered # sign		
3.0	Obtain contamination samples		C	
3.1	Obtain masslin wipes	Wiped area < 100 sq. ft. Wipe folded and placed in bag		
3.2	Obtain disc smears	S-shape area =100 sq.cm. Each smear folded		

JOB PERFORMANCE MEASURE

Radiation Worker

Task Number: HRT-01-03

TASK

Perform an airborne survey

CONDITIONS UNDER WHICH TASK IS TO BE PERFORMED

Given an airborne area work assignment (potential) with specific RWP and health physics pre-job briefing.

HOW WELL THE TASK HAS TO BE PERFORMED

To the standard of SNPS operating procedures as outlined

MATERIALS/TOOLS/REFERENCES YOU MUST OBTAIN

Portable air samplers (Radeco, Ras-1), particulate filters, charcoal filters, and plastic bags.

SP 62.010.01 SP 62.030.01 SP 63.032.01

WHAT SHOULD PROMPT YOU TO PERFORM THIS TASK

Assigned work in an airborne area (actual or potential).

PROCESS OF GRADING PERFORMANCE

1. Failure of a critical step constitutes failure of the task.
2. All critical steps must be performed in order.

Trainee: ______________ Date: ________ Position: ______________

Signature: ______________ Social Security Number: ______________

Evaluator: ______________ Date: ________ Position: ______________

Signature: ______________

STEP #	DESCRIPTION		C.E.	COMPLETED
1.0	Select air sampler		C	
1.1	Determine type air sample needed	General area or breathing zone		
1.2	Locate sampler	In work area or in general area		
2.0	Prepare sampler		C	
2.1	Inspect air sampler	Callibration current No visible damage		
2.2	Install filters	Particulate = fuzzy side up Charcoal = lip up or arrow down		
3.0	Obtain an airborne radioactivity sample		C	
3.1	Determine collection period	Time period to nearest second Sample volume > 500L or 18 cu.ft.		
3.2	Position sampler for general area	Select area most accessible to workers (usually mid-walkway)		
3.3	Position sampler for breathing zone	Select area at worker location at least 3 ft. from contaminated surface.		
3.4	Record data	Use triangle to mark sampler location on survey map.		

APPENDIX H

INSTRUCTIONAL OBJECTIVES

RADIATION WORKER
RADIOLOGICAL SURVEYS
OBJECTIVES

This lesson will enable the trainee to independently perform radiological surveys for radiation, contamination, and airborne radioactivity. Each **TASK** is listed and followed by the necessary **performance steps**. Listed under the performance steps are the enabling knowledge/ skill **objectives** to the standard of the student text.

PERFORM A RADIATION SURVEY

1. **Select a dose rate meter**
    a. Given a description of the radiological conditions present in an area, select the portable survey instrument(s) to perform a general area survey to procedural standards.

    b. Given an RO-2 and Teletector, identify the operating scales, giving the range of each in mRem/hr.

2. **Perform the preoperational checks on a portable radiation dose rate instrument, prior to use.**
    a. List the preoperational checks and procedural acceptance criteria for portable radiation survey instruments.

    b. Compare the difference in preoperational checks for the Teletector and RO-2 as found in the student text.

3. **Obtain general area dose rates.**
    a. Given survey maps, identify survey locations for "General Area" radiation surveys, using the procedure guidelines.

    b. State the methods used to minimize personal exposure when performing surveys in unknown or expected high radiation areas, using the procedure guidelines.

    c. State the methods used to establish instrument scale selection prior to initial entry into a radiologically controlled area, using the procedure guidelines.

d. Identify the reasons for using protective wrapping with portable survey instruments, as found in the student text.

4. **Obtain contact dose rates.**
   a. State the methods used to obtain contact dose rates. Compare this to general area surveys using the procedure guidelines.

   b. Identify any contact radiation survey data that meets "hot spot" posting criteria, as found in the procedure.

5. **Obtain beta dose rates.**
   a. Given open window and closed window readings and a beta correction factor, calculate beta dose rate to the nearest Rad.

6. **Complete a radiological survey map.**
   a. Given radiological conditions, complete a radiological survey map for a work area, using standard symbols.

   b. Given changing radiological conditions, determine the correct posting for an area, and compare this to any postings in effect.

PERFORM A CONTAMINATION SURVEY.

1. **Determine the survey method.**
   a. Define radioactive contamination and describe its sources as found in the student text.

   b. State the purpose of a "qualitative" contamination evaluation, as found in the student text.

   c. State the purpose of a "quantitative" contamination analysis, and compare this to qualitative. Use the procedural guidelines.

2. **Prepare disc smears and masslin wipes.**
   a. Identify the sample media to be used to perform qualitative and quantitative smear surveys, using the procedural guidelines.

b. Identify the allowed area for using a single disc smear and single masslin wipe, according to procedure, to the nearest cm^2 and ft^2.

3. **Obtain contamination samples.**
   a. Identify the methods used to prevent smear sample cross contamination, as found in the student text.

   b. Identify the recommended amount of pressure to be applied to a smear during the performance of a smear survey as found in the student text.

4. **Complete a contamination survey map.**
   a. Given varying levels of contamination in different areas (survey maps), complete the survey maps using standard symbols.

   b. Compare survey maps to postings, using the procedural guidelines.

PERFORM AN AIRBORNE SURVEY.

1. **Select the air sampler.**
   a. Identify the sources and causes of airborne radioactive material, as found in the student text.

   b. Identify the three major types of routinely sampled "airborne" radioactivity, and describe each hazard as found in the student text.

   c. Given a description of environmental and radiological working conditions, identify the air sampler to perform breathing zone, job coverage, and general area air samples, using the procedural guidelines.

2. **Prepare the sampler.**
    a. Identify the "positioning" of particulate and charcoal filters for particulate and iodine sampling, as found in the student text.

    b. Describe how to prepare for gas sampling, and compare this to particulate and iodine sampling, as found in the student text.

3. **Obtain an airborne radioactivity sample.**
    a. Identify the air sampler(s) and filter cartridges used to selectively sample iodine in the presence of high concentrations of noble gases, as found in the student text.

    b. Identify the minimum sampling volume which must be obtained when using the RAS1 and RADeCO samplers, to the nearest cubic foot, or nearest liter.

    c. Given various sampler positions, identify examples of correct/incorrect positioning, using the guidelines of the student text.

4. **Complete an airborne survey map.**
    a. Given various maintenance tasks and radiological conditions, complete survey maps using standard airborne symbols

References:

1. HRT student text handouts
2. SNPS Operating Procedures listed below:

SP 61.080.01:	Control of Health Physics Instrumentation
SP 62.010.01:	General Radiation Survey Techniques
SP 62.020.01:	General Contamination Survey Techniques
SP 62.030.01:	Airborne Activity Survey Techniques and Determinations
SP 63.010.03:	Operation of Eberline Model RO-2 and RO-2A Ion Chambers
SP 63.010.05:	Operation of Eberline Model 6112 "Teletector"
SP 63.032.01:	Operation of Portable Air Samplers

Advanced Study Options

1. Eberline Instrument Corporation Technical manuals for the RO-2/RO-2A, and Teletector.
2. Computer based training module: "Changing Conditions: The Fuel Flea" or General Physics text "hot particles."
3. Computer based training module: "Changing Conditions:Activation" or NSS slide/tape "activation products."
4. General Physics text "high radiation surprises."

APPENDIX I

PROGRESS TESTS

Radiation Worker
Radiation Survey
Progress Test 1

1. Given 2 survey maps, describe whether you would perform a general area or work area survey. List your reasons.

2. List the 5 preoperational checks for an RO-2 portable survey instrument. How does the Teletector differ? What is the acceptance criteria for each check?

3. You are about to enter a high radiation work area. Describe the precautions you would take.

Progress Test 1 (cont.)

4. When performing a work area survey, describe 3 ways to minimize your dose.

5. Describe how to take beta and gamma contact dose rates. List the 2 criteria that determine a "hot spot."

6. Given the survey map of a work area, plan a radiation survey. Use standard symbols for head, waist, and knee readings. Show any planned contact readings.

Radiation Worker
Contamination Survey
Progress Test 2

1. Contrast qualitative and quantitative contamination evaluations. List media and area of each.

2. Given 2 survey maps and anticipated contamination levels, plan the contamination surveys. Use no more than 20 smears and 2 wipes. Record planned swipe locations using standard symbols.

3. Describe the posting requirements for contaminated areas.

Radiation Worker
Airborne Survey
Progress Test 3

1. Compare the 3 types of air samples. In your comparison, include sampler type, filter and volume requirements.

2. Given 2 survey maps and radiological conditions, decide where to take the air sample. Show location on survey map, using standard symbols.

APPENDIX J

LESSON PLAN AND PROGRESS TESTS WITH CRITERIA

HEALTH PHYSICS FOR RADIATION WORKERS

RADIOLOGICAL ASSESSMENT SKILLS

LESSON PLAN

HRT-LP-01

REV. 1

PREPARED BY: Engel 1/26/89
TRAINING INSTRUCTOR /DATE

DATE 01/26/89

TECHNICAL REVIEW: ______
HEALTH PHYSICS ENGINEER /DATE

INSTRUCTIONAL ADEQUACY REVIEW: ______
INSTRUCTIONAL TECHNOLOGIST /DATE

APPROVAL FOR USE: ______
TECHNICAL TRAINING SUPERVISOR /DATE

HRTLP01/31
F02

LESSON TITLE:

Radiological Assessment Skills

TASK(S):

HRT-01-01 Perform a radiation survey.

HRT-01-02 Perform a contamination survey.

HRT-01-03 Perform an airborne survey.

SETTING:

Classroom/Lab.

APPROXIMATE DURATION:

8 - 16 Hours

LESSON OBJECTIVE(S):

Upon completion of this lesson, the trainee will demonstrate mastery of the enabling objectives, to the standard of the student text.

ENABLING OBJECTIVES:

HRT-01-01.K01	Given a description of the radiological conditions present in an area, select a portable survey instrument(s) to perform a general area survey.
HRT-01-01.K02	Given an RO-2 and Teletector, identify the operating scales, giving the range of each in mRem/hr.
HRT-01-01.K03	List the preoperational checks and acceptance criteria for portable radiation survey instruments.
HRT-01-01.K04	Compare the difference in preoperational checks for the teletector and RO-2 as found in the student text.
HRT-01-01.K05	Identify the reasons for using protective wrapping with portable survey instruments.

HRT-01-01.K06	State the methods used to establish proper instrument scale selection prior to initial entry into a radiologically controlled area.
HRT-01-01.K07	State the methods used to minimize personal exposure when performing surveys in unknown or expected high radiation areas.
HRT-01-01.K08	Given survey maps, identify survey locations for "General Area" radiation surveys.
HRT-01-01.K09	State the methods used to obtain contact dose rates. Compare this to general area surveys.
HRT-01-01.K10	Identify any contact radiation survey data that meets "hot spot" posting criteria.
HRT-01-01.K11	Given open window and closed window readings and a beta correction factor, calculate the beta dose rate to the nearest Rad.
HRT-01-01.K12	Given radiological conditions, complete a radiological survey map for a specified area, using standard symbols.
HRT-01-01.K13	Given radiological conditions, determine the correct posting for an area, and compare this to any postings in effect.

HRT-01-02.K01	Define radioactive contamination and describe its sources.
HRT-01-02.K02	State the purpose of a "qualitative" contamination evaluation.
HRT-01-02.K03	State the purpose of "quantitative" contamination analysis, and compare this to qualitative.
HRT-01-02.K04	Identify the sample media used to perform qualitative and quantitative smear surveys.
HRT-01-02.K05	Identify the maximum area for using a single disc smear and a single masslin wipe.
HRT-01-02.K06	Identify the methods used to prevent cross contamination of smear samples.
HRT-01-02.K07	Identify the recommended amount of pressure applied to a smear during the performance of a smear survey.
HRT-01-02.K08	Given varying levels of contamination in different areas, complete the survey maps using standard symbols.
HRT-01-02.K09	Compare survey maps to postings.
HRT-01-03.K01	Identify the sources and causes of airborne radioactive material.

HRT-01-03.K02	Identify the three major types of routinely sampled "airborne" radioactivity, and describe each hazard.
HRT-01-03.K03	Given a description of radiological working conditions, identify the air sampler to perform breathing zone, job coverage, and general area air samples.
HRT-01-03.K04	Identify the "positioning" of particulate and charcoal filters.
HRT-01-03.K05	Describe how to prepare for gas sampling, and compare this to particulate and iodine sampling.
HRT-01-03.K06	Identify the air sampler(s) and filter cartridges used to selectively sample iodine in the presence of high concentrations of noble gases.
HRT-01-03.K07	Identify the minimum sampling volume which must be obtained when using the RAS-1, and the RADeCO samplers to the nearest cubic foot, or nearest liter.
HRT-01-03.K08	Given various sampler positions, identify examples of correct/incorrect positioning.
HRT-01-03.K09	Complete airborne survey maps

INSTRUCTIONAL MATERIALS:

- White board & Markers
- Overhead Projector
- Transparencies
- RO-2
- Teletector
- RAS - 1 and sample head
- RADeCO Sampler and head
- Survey maps
- Masslin wipes & smears
- Hot Spot markers
- Plastic bags and tape
- 4 Liter Marinelli

STUDENT MATERIALS:

Dacum Chart
Learning Objectives
Student Text

REFERENCES:

1. Eberline Instrument Corporation Technical manuals for the RO-2/RO-2A, and Teletector.
2. SP 61.080.01 Control of Health Physics Instrumentation.
3. SP 62.010.01 General Radiation Survey Techniques.
4. SP 62.020.01 General Contamination Survey Techniques.
5. SP 62.030.01 Airborne Activity Survey Techniques and Determinations.
6. SP 63.010.03 Operation of Eberline Model RO-2 and RO-2A Ion Chambers.
7. SP 63.010.05 Operations of Eberline Model 6112 "Teletector."
8. SP 63.032.01 Operation of Portable Air Samplers.

OUTLINE OF INSTRUCTION	INSTRUCTIONAL ACTIVITIES
I. **INTRODUCTION**	
Instructor Introduction: initial class meeting only	Introduce self, relating background in subject area. Be aware of trainee background or have students introduce themselves. If necessary, make any class policy statements. Smile and demonstrate friendly atmosphere.
A. Purpose: Facilitate the necessary learning to support radiation, contamination and airborne survey performance.	
B. Scope: Radiation surveys include general area, contact and beta dose rate; contamination surveys include disc smears and masslin wipes; airborne surveys include particulate and charcoal samples from portable air samplers. The scope of the lesson may be limited by the Instructor.	The scope of the Lesson can be introduced by showing the ten minute film of the SNPS IRM detector removal. Ask students to look for and list the tasks performed by workers and the HP technicians. After discussing these, ask students how they would feel about performing both tasks themselves. Allow time for thorough discussion.
C. Lesson Overview	
1. Present Dacum Chart	Compare the 4 tasks with those identified by students in the film.
2. Present Lesson Objectives	Show how the objectives relate to the steps of each task.
II. **Radiation Surveys**	Demonstrate RO-2 to class. Show beta window and correction factor $\left(\frac{\text{mrad}}{\text{Mr}}\right)$ on side of instrument.
A. Survey instruments and scale ranges	
1. RO-2	

OUTLINE OF INSTRUCTION	INSTRUCTIONAL ACTIVITIES
a) Capability to measure gamma exposure rates as well as beta.	Point out it is an **ion chamber**. Introduce theory of operation with **TP1** then handout RO-2's and look at chamber.
b) Scale ranges .5 MR/hr. to 5000 MR/hr.	Ask student to recall why this is good for dose rates? Emphasize its advantages in terms of simplicity of operation (primary ionization only) and reliability (vented to air chamber).
c) Limitations	
2. Teletector	Demonstrate to class. Point out it is GM instrument with 2 detectors. Low range can detect both gamma and beta; high range gamma dose rate only. Introduce theory of operation with **TP-2**.
a) capability to measure gamma and detect beta exposure rates	
b) scales include low range of 2 MR/hr, 50 MR/hr, 2R/hr and high range of 1000 R/hr	Show class the 10 ft. extension capability and ask how this could be utilized? Note that it is for very high radiation source identification, often "hot spots" **TP-3**
c) limitations	Emphasize **ALARA** capabilities.
B. General Area Radiation Surveys	Handout and give the class several examples of general area surveys from routine clean areas to undervessel IRM detector removal. Use **TP-4** to show the purpose of radiation surveys.
1. Selection of appropriate instrument based on capability.	
2. Selection of appropriate instrument based on ALARA and range considerations	Given the situation, have each student select an instrument & ask class if they agree and why?
C. Preoperational checks for portable Radiation Survey Instruments (**reliability**)	Emphasize the importance of **reliable** and correctly working instrumentation. Pay attention to instrument serial number which will be needed for each survey.

1. Calibration: date and date due 2. Physical Inspection: meter faces, handles, punctured beta windows	Show location on instrument. (RO-2 and Teletector) Point out the need to be legible and current. If used for beta, the beta correction factor must be displayed (BCF). Stress that if problems are found the instrument should be removed from service & repaired.
3. Battery check: positive indication	Point out that for the detector to work it must have adequate power - even a "low" indication is not adequate.
4. Meter Zero: meter function switch to "zero" then "zero control" adjustment.	Demonstrate with RO-2 Point out that **ion chambers** such as the RO-2 have this zero adjustment. Stress that this should also be checked periodically during operation. It is an electronic zero and is not affected by radiation fields.
5. Source check	Show that this involves exposing instrument to a known exposure/dose rate.
D. Preoperational check Acceptance Criteria	At this point ask trainees what they think the acceptance criteria would be.
1. Calibration: current	
2. Inspection: working	
3. Battery check: better than low	
4. Meter Zero: adjusted to zero	

5. Source check: ± 20% of source strength indicated on source.	Point out that this determines whether the instrument responds within an acceptable range. These pre-calculated limits are labeled on the source holder. Have trainees source check the RO-2 using a uranium slab source.
E. Survey Performance: Instrument Wrapping	Demonstrate a wrapped RO-2. Mention there are many ways to do it.
1. Protection from contamination	
2. Clean plastic to view instrument controls and readouts	
3. Controls can be adjusted	
4. Instrument response is not altered 5. The wrapping can be easily removed.	Point out that beta window cannot be covered. Ask students to recall why. Low level beta will not penetrate the plastic. Show TP-5 to illustrate penetrating radiation.
F. Survey performance: Scale selection 1. Expected dose rate	Emphasize that the trainee never wants to be in a position where an instrument is offscale and radiation exposure cannot be measured.
a) previously written RWP's	
b) completed surveys	
2. Exceed expected rate with scale selection: start high then switch down.	Ask students how long they think it would take for an overexposure. Several seconds may be too late. Write example on board. Emphasize ALARA. ALARA is always the premier concern.

G. Survey Performance: minimizing personal exposure in "unknown" or high rad areas	
1. Survey only area specifically identified **(work area)**	Point out this is usually the RWP specified **work** area. Other areas are only "general area" surveys.
2. Survey Plan & Data Collection	Proper planning saves a lot of dose.
a) pre-number smears	Ask students if they have dose saving ideas (depending on experience level of trainees) use brainstorming technique and write on flip chart.
b) Use map; if necessary use grid	
c) survey work area, hot spots first, then fill in	
d) record data periodically (outside high dose areas).	
3. **ALARA** Considerations	Point out that doorways are often temporary locations for resin drums, trash, PC's. The dose rates build. Have trainees recall that dose rates are additive.
a) dose rate at doors/entrances	
b) detector in direction of travel	
c) shielding present in work environment	Point out that many areas are designed with labyrinths that block or shield direct radiation. **TP-6**
d) Instrument malfunction: leave area immediately.	
H. Survey Performance: General Area	Point out these are general plant areas accessible to personnel, usually high traffic.
1. Waist level	

OUTLINE OF INSTRUCTION	INSTRUCTIONAL ACTIVITIES
2. Eighteen inches from sources	The number of readings depend on total square footage and variability of dose rate-a judgement call. Give examples using **TP-7**.
3. Highest value	Point out that an area is scanned and the highest value is recorded.
4. Variation of dose rate	To determine this, the detector is moved up & down between head and knee to evaluate the variation of general area dose rates.
5. Floor or overhead source	Emphasize the dose rate would be where the highest "whole body" dose rate occurs. Head from overhead, or knee from floor. If other than waist level, record information (H or K).
6. Low dose areas (**waiting areas**)	Be sure to indicate these locations on survey map (LDA).
I. Survey Performance: Contact Dose Rates	Emphasize contact surveys are to identify the highest radiation doses present in work area.
1. Sensitive volume of detector at source	Place detector as close as possible to source. Demonstrate sensitive area of each instruments' detectors. Ask why?
2. Eighteen inch dose rate to accompany each contact reading.	
J. Survey Performance: "Hot Spot"	Have trainees recall that Hot Spots should be spotted with marker (show students) and recorded on survey maps.
1. Contact dose rate > four times general area.	
2. Dose rate > 100 m rem/hr contact	At this point review and show **TP-8** with H, K, LDA and HS labeling on survey may. Emphasize the use of standard symbols.

K. Survey Performance: Beta Dose Rates 1. Beta correction factor in rad/R (BCF)	Mention that any time contamination is encountered, beta radiation is also. Found in primary systems, spent resin, and sump pump sludge. Of concern are the eye and hand positions. Ask trainees to recall why? GET Training. Point out that the BCF accounts for geometry errors (betas not reaching the sensitive volume of the detector) and corrects for the difference in beta and gamma response by the instrument. Show TP-9 with RO-2 response to radiation.
2. Obtain contact reading OPEN WINDOW (OW)	Point out this is a beta-gamma reading.
3. Obtain contact reading CLOSED WINDOW (CW)	This is a gamma reading (just like the source check).
4. OW - CW = beta response	Use board and show several examples of (OW-CW = br) x BCF.
5. Record Beta dose rates even if none detectable.	Point out that if no note is made on the survey sheet of beta readings it is not apparent whether it was forgotten or or there were none. Have each trainee obtain beta reading using RO-2 and uranium slab source. Compare readings.
L. Radiological Survey Sheet	Handout blank survey maps.
1. Legal record 2. Complete (use NA) 3. Legible 4. Black ink	Have the trainees plan a survey of the "fit booth". Plant the uranium source overhead and ask for contact beta readings. Review completed survey maps for completeness show model TP-10.

M. Radiation area postings 1. Radiation Area: 2.5 mr/hr General Area 2. High Radiation Area: 100 mr/hr G.A. 3. Hotspot: 4 x GA (>100 mr/hr)	Engage class in review of area definitions. Give examples of each, found at Shoreham. Point out that once the survey data is collected, the area must be "posted". If it is already posted, it must be updated. Handout posting debate exercise and facilitate the debate. At this point ask if there are any questions on "Rad" surveys/techniques or how to use the RO-2 or TT. Give trainees the student handout (text) on Rad Surveys. Provide opportunity to study/review. Have trainees complete **progress test 1**.
III. **Contamination Survey Techniques**	Ask a student to define contamination and give examples at Shoreham. Recall origin in fission product production and activated corrosion products. Point out that any system which carries or contains primary water or is associated with the reactor clean up system is a potential source of contamination. Have students recall that when you have contamination you have beta. Show **TP-11** to stimulate recall of alpha, beta, gamma radiation. If needed show slide/tape of "Ionizing radiation".
A. Radioactive Contamination 1. Beta - gamma vs. alpha 2. Fixed vs. Loose (Smearable) a. porosity	Point out that neutron activated corrosion products & fission products will emit beta-gamma. Alpha emitting radionuclides are heavy nuclei and remain with the fuel.

OUTLINE OF INSTRUCTION	INSTRUCTIONAL ACTIVITIES
b. chemical bond	Emphasize that loose is what a contamination survey finds and that fixed has a chemical bond with its surface. Whether fixed or loose depends on porosity of contaminated surface, physical form of contaminant, electrostatic forces, and ambient air conditions. Ask students: What could cause "fixed" to become loose (grinding, cutting, heating and drying)?
B. Qualitative Contamination Evaluation (quick)	Ask students to recall the difference between qualitative vs. quantitative.
1. Presence	
2. Spread	
C. Quantitative Contamination Analysis	Emphasize that once contamination is discovered, qualitative evaluation is followed by quantitative analysis; to identify how much is there.
D. Contamination Sample media	
1. Qualitative: masslin wipe	Point out that this is an oil based cloth for wiping large surface areas, such as floors and ceilings (dust mop) and hand rails. The oil cloth easily absorbs contaminants.
a. absorbs	
b. Convenient for walls, ceiling, handrails, large areas.	
2. Quantitative: Disc Smear	Point out this concentrates activity over a small area enabling detection of lower levels of contamination.
a. concentrates	
b. used to quantify	
c. used to verify "clean"	

E. Single Masslin or Smear Area	Demonstrate each to class.
1. Masslin: < 100 ft^2	Mark off 100 ft^2 on floor. Draw 100 cm^2 on board (4 in^2)
2. Smear: 100 cm^2	
F. Prevention of Cross Contamination	Until evaluated, each wipe or smear is to be treated as contaminated.
1. Masslin: folded then bagged and numbered	Demonstrate. Ask students why numbered bags. Emphasize prevention of cross contamination and survey documentation.
2. Smears: numbered envelopes or folds	Demonstrate use of smears. Emphasize "flatness" for counting.
G. Performance of Smear Survey	
1. Pressure applied to Smear	Point out that "moderate" generally works (about 5lbs/in^2). Do not tear the smear.
2. Documentation	Show contamination surveys **TP-12**. Point out that heavily travelled areas, SOP's, drains & areas of greatest potential are surveyed. Note circles with numbers.
3. "Gross Smears"	Point out that if an area > 100 cm^2 is smeared note in the comments section "gross smears" vs. dpm/100 cm^2. If something is found, further **quantitative** analysis is required. Ask for any questions. Review Radiological Survey sheet for inclusion of both Rad and Smear information.
4. Technique	The number of smears depends on contamination previously found or expected (spills). Before surveying, pre-number smears.

OUTLINE OF INSTRUCTION	INSTRUCTIONAL ACTIVITIES
	Have trainees wipe/smear area in lab using trainee created spill scenario. Handout student text on contamination surveys. Allow study time. Have trainees complete **progress test 2**.
IV. **Airborne Survey Techniques**	Emphasize that engineering controls minimize airborne problems, containment structure, flow of air HVAC System, HEPA and charcoal filters.
A. Sources of Airborne Contaminants	Large amounts being stirred up create airborne Show **TP-13** ingestion.
1. Contamination a) maintenance activity 1) cutting 2) welding 3) grinding	Point out that cutting by acetylene torches disturbs a contaminated surface. Particles then circulate into the air. Similarly the heat created by welding causes particles to be atomized and airborne. Grinding with abrasive grinding wheels poses the most significant problem, dislodging large amounts of formerly fixed contamination. Have trainee recall that these would be the beta contact reading from the rad survey.
b) system operations	Briefly, introduce use of decon, tent/glove box for cleaning or containing.
	Emphasize changing conditions are caused by equipment failure, steam leaks, loss of negative pressure and spills: generally contamination and airborne.
2. Natural Sources: radioactive daughters of the Uranium & Thorium natural decay series	Point out the origin of the gases **RN220** & **RN222** by diffusion through the soil. This activity can mask other activity. Ash how?

B. Airborne Activity	Emphasize that the type of activity determines the filter media and sampling instrument.
1. Types of Airborne	Prior to sampling the situation needs to be evaluated.
a) Particulate	Point out that this is the most common form of airborne consisting of particles, usually from surface contamination. Show **TP-14** to show types.
b) Iodine	Point out this is from the halogens. Radioiodine, because of its thyroid seeking properties, is of greatest concern. Ask students if they are familiar with organ dose. Emphasize that Radioiodine is a product of the fission process and as a result can be found throughout the plant.
c) gases	Point out that noble gases are chemically inert (**Xe**, **Kr**, **Ar**) and therefore present no internal hazard. Ask students what the hazard would be. Skin and whole body exposure result from beta & gamma emissions. Tritium (H_3) is also of concern & can be in the form of water vapor or gas. Ask students if they recall its origin. In BWR's it is ternary fission & deuterium neutron capture. Use slide/tape "Activation Products".
2. Air Sampling Methods	
a) Particulate Collection	Point out that this is accomplished through filtration using a glass fiber filter. (Handout filters to trainees.)
1) filtration	Ask students about filter effectiveness.

2) samplers	Point out that the basis of any sampler is: (1) air inlet (2) filter holder (3) vacuum pump (4) air outlet. They may be portable or installed; continuous monitor (on-line) or grab sampler.
3) portable monitors	Ask student to explain grab sampling. Note that high volume samplers operate at flow rates of 10-50 cfm & are used when an air sample is required in a short period of time. Ask students to give an example. Low volume samplers operate at flow rates of less than 10cfm usually 2-4 cfm range.
b) Iodine Collection	Point out that the collection efficiency is 80-90% provided the flow rate is $\leq$ 2 cfm. Emphasize that the only problem with charcoal is its affinity for Xenon.
1) activated charcoal	
2) silver zeolite	Ask students how they would collect an iodine sample in the midst of a lot of noble gas.
c) Gas Sampling	Point out that continuous sampling needs to be representative. Note: Tritium is in the form of water vapor and can be collected by passing sampled air through a collection chamber surrounded by cold water. Demonstrate use of 4 liter marinelli chamber for collecting gas with water displacement or vacuum.
1) grab	
2) continuous	
3) Tritium	
C. Use of Air Samplers	
1. Eberline RAS-1	Ask students why they think the ease of head changeout might be beneficial.
a) Lo vol (0.5 - 3.0 cfm)	

b) Particulate	Used for sampling iodine using AgZ.
c) Iodine	Demonstrate RAS-1
2. RADeCo Portable	
a) Flow variable	Demonstrate RADeCo
b) Particulate	Ask students what would make the sample a "breathing zone." Why is this important? It is used to obtain grab samples before, during, and after work. Ask a student to explain why this would be necessary. Emphasize planning ahead is required, electrical outlet locations, and extension cords. A battery powered unit is available for locations with no outlets. Ask trainees, with their knowledge of air sampling capability, how they would design a sampling program and why.
c) Breathing zone	
d) General Area	
e) Battery	
4. Air Sampling Program	
a) Estimate potential uptake	
b) Data (for selection of protective measures and control of long term working exposure & requirements for engineering controls)	Write consensus program on board, Ask if potential hazards can be evaluated with this program. Ask students how this is used in conjunction with a respiratory protection program. Compare with Shoreham's program.
c) Documentation (personnel exposure)	Present students with examples and have them point out sampling methods.
d) Identify contaminants and sources	
e) Effectiveness of existing controls	Changing conditions would be identified by e - h.
f) Warning of deterioration of equipment or procedures	
g) Trending (long term by area)	
h) Environment	

D. Positioning of Filters	Demonstrate filter placement (charcoal and particulate) in each of the portable samplers. Emphasize flow direction (fuzzy side up, flow in direction of arrow) Have trainees load filters.
E. Use of Silver Zeolite	Ask students to recall its use.
F. Air Sampling Volumes	Give example of RAS-1: flow rate at 50 LPM, runs for 10 min.
1. 500L (18 ft^3) minimum	
2. variable	RADeCo is adjustable. Write example on board: If operated at 2cfm, it takes 9 min for 500 L
3. representative	$(2 \frac{ft^3}{min} \times \frac{28.32L}{ft^3} \times 9\ min = 510L)$
G. Air Sampler Positioning and Data Collection 1. Positioning	Have trainees collect air samples, both a general area and breathing zone sample using the RADeCo. Give radiological conditions and simulate SNPS location in the lab.
a) away from contaminated surface. b) breathing zone	Emphasize that sample needs to be as close to workers BZ as possible but head should be 3 ft. away from a contaminated surface.
c) out of the way	
2. Data	Show **TP-15** of sample data information. Point out RWP number, location, type sample, area code, person worn by (if applicable), tech's name, air sampler & serial #, date, time, flowrate, sample On-Off time. Have trainees use board to calculate volume of given examples.
3. Cross Contamination	Demonstrate removing filters to avoid dropping. Point out gloves or tweezers need to be used. Put in labeled bag to frisk, then transport to counting room. Have trainees fill out label.

V. SUMMARY

Use **brainstorm** on survey pitfalls to summarize radiological assessment. Proceed to lab. exercise.

Handout student text on airborne surveys. Allow time to study and answer any questions. Have trainees complete **progress test 3**.

Radiation Worker
Radiation Survey
Progress Test 1

1. Given 2 survey maps, describe whether you would perform a general area or work area survey. List your reasons.

- The general area survey is the route to the work area, the elevation in general, and the low dose waiting area.
- The work area survey is at the location of the specific component. This is where the worker is located while performing the job task.

2. List the 5 preoperational checks for an RO-2 portable survey instrument. How does the Teletector differ? What is the acceptance criteria for each check?

- Ro-2 preoperational checks
    1. Physical condition
    2. Calibration sticker
    3. Battery check
    4. Zero, meter check
    5. Source check

The Teletector differs in that the source check is performed by HP and the instrument is tagged. There is no zero check.

3. You are about to enter a high radiation work area. Describe the precautions you would take.

- Review prior surveys for expected radiation levels.
- Compare oldest and newest surveys for potential change
- Dress out and follow the RWP requirements
- Use extended teletector for hot spot and initial readings
- Make use of labyrinth and any other shielding available

Progress Test 1 (cont.)

4. When performing a work area survey, describe 3 ways to minimize your dose.

1. Minimize time in the area
2. Use available sheilding
3. Keep a maximum distance between you and sources of radiation

5. Describe how to take beta and gamma contact dose rates. List the 2 criteria that determine a "hot spot."

- Gamma is a closed-window reading
- Beta is open-window minus closed window times the beta correction factor

- The detector must be within 1/2 inch of source

- Hot spot is determined by:
  1. Dose reading > 4 times general area
  2. Dose reading > 100 mrem/hr

6. Given the survey map of a work area, plan a radiation survey. Use standard symbols for head, waist, and knee readings. Show any planned contact readings.

Surveys should include:

- contact readings on components
- identified hot spots
- general area includes walk way
- more readings in area where job is performed
- use of available sheilding

Radiation Worker
Contamination Survey
Progress Test 2

1. Contrast qualitative and quantitative contamination evaluations. List media and area of each.

Qualitative is an indication only. Masslin is used.

Quantitative specifies the amount of contamination in units of dpm/100 cm^2.

2. Given 2 survey maps and anticipated contamination levels, plan the contamination surveys. Use no more than 20 smears and 2 wipes. Record planned swipe locations using standard symbols.

- Heavy contamination areas require more smears
- Components, tables and walls need to be included
- Use masslin wipes to detect any spread adjacent to area
- Smear step-off pad last

3. Describe the posting requirements for contaminated areas.

If the contamination is greater than 1000 dpm/100cm^2 it is posted as contaminated

Radiation Worker
Airborne Survey
Progress Test 3

1. Compare the 3 types of air samples. In your comparison, include sampler type, filter and volume requirements.

1. Particulate (fiberglass filter)
   - Radeco
   - Ras-1
   - volume > 500 liters

2. Iodine (charcoal cartridge)
   - Ras-1
   - volume > 500 liters

3. Gas
   - evacuated cylinder
   - volume 4 liter marinelli

2. Given 2 survey maps and radiological conditions, decide where to take the air sample. Show locaion on survey map, using standard symbols.

- Breathing zone in work area at job location

- General area or elevation somewhere along route to work area.

APPENDIX K

LABORATORY PLAN

HEALTH PHYSICS FOR RADIATION WORKERS

RADIOLOGICAL ASSESSMENT SKILLS

LABORATORY PLAN

HRT-LO1

REV. ________

PREPARED BY: ______________
INSTRUCTOR/DATE

DATE _____________

TECHNICAL REVIEW: __________

H.P. ENGINEER/DATE

INSTRUCTIONAL REVIEW: ______
TECHNICAL TRG. SUP.

LABORATORY DATA PAGE HRT-L01

TITLE:

Radiological Assessment Skills

JOB CLASSIFICATION:

Radiation Worker

PREREQUISITES:

Prior to participating in the Laboratory, the worker will have demonstrated mastery of the classroom objectives for HRT-LP-01.

SETTING:

Health Physics Lab. 101 and Room 405

APPROXIMATE DURATION:

2 to 4 hours

TERMINAL LEARNING OBJECTIVE:

In the Lab under simulated working conditions, the student will perform radiation, contamination, and airborne activity surveys using Shoreham procedures to the standard of the Job Performance Measures.

REQUIRED MATERIALS:

1. Eberline Model RO-2
2. Teletector
3. Survey Sheets
4. Disc Smears
5. Masslin wipes/bags
6. Frisker
7. Radeco 809V AC powered sampler
8. Particulate filters
9. Scott charcoal filters
10. Protective clothing
11. JPM's for each task
12. Lab Exercise Instruction Sheets (Job, Maps, and Information)

REFERENCES:

Shoreham Operating Procedures

LABORATORY DATA HRT-L01

TASKS WITH SUPPORTING ENABLING OBJECTIVES:

HRT-01-01 Given survey instruments, prior survey information, RWP, and radiological survey sheets; under simulated working conditions in the laboratory; **perform a radiation survey** to the standard of the JPM; include the following steps:

P1. Select a dose rate meter
P2. Perform preoperational checks
P3. Obtain general area dose rates
P4. Obtain contact dose rates
P5. Obtain beta dose rates

HRT-01-02 Given disc smears and masslin wipes, a frisker, bags, RWP and survey map; under simulated working conditions in the laboratory; **perform a contamination survey** to the standard of the JPM; include the following steps:

P1. Determine the survey method
P2. Prepare disc smears and masslin wipes
P3. Obtain contamination samples

HRT-01-03 Given air samplers, filters, and sample envelope; under simulated working conditions in the laboratory; **perform an airborne survey** to the standard of the JPM; include the following steps:

P1. Select the sampler
P2. Prepare the sampler
P3. Obtain an airborne radioactivity sample

INTRODUCTION:

A demonstration of each Task has been given as part of the lesson, or may be given here. Normally the Lab will immediately follow the classroom lesson. In the Lab the trainees will perform at their own pace, practicing each step of each task to the standard of the JPM. When each step has been demonstrated and mastered, the instructor will initial the JPM critical step (C).

LABORATORY OUTLINE	TRAINING ACTIVITIES
I. Procedure The Lab consists of identifying the radiological hazards in a simulated work area. For a complete assessment the trainee must perform 3 surveys: radiation, contamination, and airborne.	Job Sheets and Job Planning Format are attached.
The Lab is **self-paced** and guided by the Job Sheet. Additional information is provided on **Information Sheets.** The Instructor will provide an RWP and blank survey sheets.	
Specific information on an **Operation** is provided by a working copy of the procedures.	Point out that these are available in the Lab.
Begin with the Job Sheet. Trainees may plan the survey as a group or individually.	Hand out Instruction Sheets and JPM's for the surveys. Go over with the trainees, asking for any questions. With 6 trainees you may divide the group; one will observe and check off performance steps to "standard" JPM, providing a critique. The groups then switch. The Instructor guides the critique, providing positive reinforcement.
	Additional Task demonstration may be required if a step is missed by a trainee.

Recall the demonstration, and have procedures and maps available. Trainees will perform the **Laboratory work** and the Instructor will observe the performance of **each step** as the trainee practices. The Instructor will help as required and will initial the JPM when satisfied the trainee can perform to standard.

More experienced/faster trainees will be asked to help fellow trainees or plan their own Lab scenario using the Job Planning Format.

II. Practice

A. Provide additional demonstration if needed. If time permits, change the conditions on the survey map. Use the high radiation contamination option.

For changing conditions spill water on the floor and set off alarms on continuous air monitor.

B. Using ion chamber simulator, increase radiation levels to indicate filling tank, line flow, or moveable hot spot.

Monitor reaction of trainees. If conditions vary by 50% they should exit area.

III. Review

A. Collect survey maps and review with trainees.

B. Use case study and discuss survey pitfalls.

Use brainstorm technique.

JOB SHEET

JOB TITLE: Radiological Surveys

UNIT: HRT

REFERENCES:

Student handout
Evaluation Instrument
Instruction Sheets
SP 12.012.01 RWP
SP 61.018.01 Rad Survey Schedule and Locations
SP 62.010.01 General Rad Survey Techniques
SP 62.020.01 General Contamination Survey Techniques
SP 62.030.01 Airborne Activity Survey Techniques

OBJECTIVES: You will perform radiological surveys

LABORATORY WORK:

Using OT Room 405, the Instructor will have setup a highly contaminated "backwash" receiving tank room. A sample, from the highly radioactive tank, will need to be taken. You find that there is a "spill" in the room. ATS reports and a prior survey will give you some idea of what to expect - but the conditions are variable depending on whether operations has recently flushed the line to the tank (possible hot spot). Prepare carefully, then perform your surveys.

To help you organize your work, check off each step:

___1. Collect and review prior surveys and RWP.
___2. Estimate dose levels, contamination and airborne.
___3. Select and prepare survey instruments and materials for surveys identified to be performed. Dress out carefully.
___4. Perform surveys to identify all the potential HAZARDS using the JPM's.
___5. Document results of surveys completely.
___6. Compile all data and input to RWP folder.
___7. Turn folder in to Instructor for review.

EVALUATION:

Successful lab completion is determined by observation of performance to the standard of the JPM's and IAW SNPS procedures. The Instructor will initial each step of the master copy JPM after you have demonstrated to standard.

APPENDIX L

STUDENT HANDOUTS

STUDENT HANDOUT

HRT-LP-01 SHO

Section 1

Radiation, Contamination, and Airborne Survey Techniques

Introduction

...Radiation Surveys

✓ ________________________________

...Contamination Surveys

✓ ________________________________

...Airborne Surveys

✓ ________________________________
____

Radiation Survey Techniques

Survey Instruments and Scale Ranges

...RO-2

✓ ________________________________

✓ ________________________________
____

✓ ________________________________

...RO-2A

✓ ________________________________

✓ ________________________________

✓ ________________________________

...Teletector

✓ ________________________________
____

✓ ________________________________
____

General Area Radiation Surveys

...Selection of appropriate instrument based on

✓ ____________________

✓ ____________________

...Instrument preoperational check

✓ ____________________

acceptance criteria : current

✓ ____________________
____

acceptance criteria : working

✓ ____________________

acceptance criteria : operating range

✓ ____________________

acceptance criteria : adjusted to zero

✓ ____________________

acceptance criteria : +,- 20% of source strength

Survey Performance

...Instrument Wrapping

✓ ____________________

✓ ____________________
____

✓ ____________________

✓ ____________________

✓ ____________________

Scale Selection

...Expected dose rate

✓ ____________________

✓ ____________________

✓ ____________________
____

Minimizing Personal Exposure in "Unknown" or High Rad Area

...Survey only area specifically identified as "WORK AREA"

...Survey plan and data colection

✓ ____________________

✓ ____________________

✓ ____________________

✓ ____________________

...A L A R A consideratons

✓ ____________________

✓ ____________________

✓ ____________________

✓ ____________________

General Area Survey

... ______________________________

... ______________________________

... ______________________________

... ______________________________

... ______________________________

... ______________________________

... ______________________________

Contact Dose Rates

... ______________________________

... ______________________________

Hot Spots

...Contact dose rate > 4X general area

...Dose rate > 100 mrem/hr on contact

Beta Dose Rates

... (BCF) Beta correction factor in rad/R

...Obtain contact reading OPEN WINDOW (OW)

...Obtain contact reading CLOSED WINDOW (CW)

...OW - CW = beta response

...Record beta dose rates even if none detectable

Radological Survey Sheet

... ________________________________

... ________________________________

... ________________________________

... ________________________________

Radiaton Area Posting

...Radiation Area

✓ ________________________________

...High Radiation Area

✓ ________________________________

CONTAMINATION SURVEY TECHNIQUES

Radioactive Contamination

...Beta / gamma vs. alpha

...Fixed vs. loose (smearable)

✓ ________________________________

✓ ________________________________

Qualitative Contamination Evaluation (quick)

...Presence

...Spread

Quantitative Contamination Analysis

Contamination Sample Media

...Qualitative : masslin wipe

✓ ____________________

✓ ____________________

...Quantitative : disc smear

✓ ____________________

✓ ____________________

✓ ____________________

Single Masslin or Smear Area

...Masslin : ____________________

...Smear : ____________________

Prevention of Cross Contamination

...Masslin

✓ ____________________

...Smears

✓ ____________________

Performance of Smear Survey

...Pressure applied to smear

...Documentation

..."Gross Smears"

...Technique

AIRBORNE SURVEY TECHNIQUES

Sources of Airborne Contaminents

...Contamination

✓ ____________________

- ________
- ________
- ________

✓ ____________________

...Natural Sources

✓ radioactive daughters of the Uranium and Thorium natural decay series

Airborne Activity

...Types of Airborne

✓ ____________________

✓ ____________________

✓ ____________________

Air Sampling Methods

...Particulate collection

✓ ______________________________

✓ ______________________________

✓ ______________________________

...Iodine collection

✓ ______________________________

✓ ______________________________

...Gas sampling

✓ ______________________________

✓ ______________________________

✓ ______________________________

Use of Air Samplers

...Eberline RAS-1

✓ ______________________________

✓ ______________________________

✓ ______________________________

✓ ______________________________

...RADeCo Portable

√ ______________________________

√ ______________________________

√ ______________________________

√ ______________________________

√ ______________________________

...Air Sampling Program

√estimate potential uptake

√data

- for selection of protective measures; control of long term working exposure; requirements for engineering control

√documentation (personnel exposure)

√identify contaminants and sources

√effectiveness of existing controls

√warning of deterioration of equipment or procedures

√trending (long term by area)

√environment

Positioning of Filters

Use of Silver Zeolite

Air Sampling Volumes

✓ ______________________________

✓ ______________________________

✓ ______________________________

Air Sampler Positioning and Data Collection

...Positioning

✓ ______________________________

✓ ______________________________

✓ ______________________________

...Data

...Cross contamination

JOB SHEET

JOB TITLE: Radiological Surveys

UNIT: HRT

REFERENCES:

Student handout
Evaluation Instrument
Instruction Sheets
SP 12.012.01 RWP
SP 61.018.01 Rad Survey Schedule and Locations
SP 62.010.01 General Rad Survey Techniques
SP 62.020.01 General Contamination Survey Techniques
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OBJECTIVES: You will perform radiological surveys

LABORATORY WORK:

Using OT Room 405, the Instructor will have setup a highly contaminated "backwash" receiving tank room. A sample, from the highly radioactive tank, will need to be taken. You find that there is a "spill" in the room. ATS reports and a prior survey will give you some idea of what to expect - but the conditions are variable depending on whether operations has recently flushed the line to the tank (possible hot spot). Prepare carefully, then perform your surveys.

To help you organize your work, check off each step:

____1. Collect and review prior surveys and RWP.
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____3. Select and prepare survey instruments and materials for surveys identified to be performed. Dress out carefully.
____4. Perform surveys to identify all the potential HAZARDS using the JPM's.
____5. Document results of surveys completely.
____6. Compile all data and input to RWP folder.
____7. Turn folder in to Instructor for review.

EVALUATION:

Successful lab completion is determined by observation of performance to the standard of the JPM's and IAW SNPS procedures. The Instructor will initial each step of the master copy JPM after you have demonstrated to standard.

JOB PLANNING FORMAT

TRAINEE'S NAME______________________________________

NAME OF JOB DESCRIPTION:

SKETCH OR DRAWING: (Trainee-made drawing as appropriate for the job).

MATERIALS REQUIRED: (Trainee figures materials for job, and inserts materials list here).

PROCEDURES AND REFERENCES: (Trainee lists procedures and references to be used).

LABORATORY WORK: (Trainee sequences work step by step).

EVALUATION: (Trainee determines criteria for successful completion of lab).

The instructor must sign this sheet before a trainee is permitted to begin.

DATE ________

INSTRUCTOR'S APPROVAL ____________________

SURVEY TYPE: ☐ Routine ☐ RWP	
% POWER:	
INSTRUMENTS:	

LONG ISLAND LIGHTING COMPANY
SHOREHAM NUCLEAR POWER STATION

AREA:

LOCATION:

SURVEY No.	
RWP No.	
DATE	
TIME	
TECHNICIAN	

N

RADIATION		
GEN'L. AREA		
CONTACT		
AIRBORNE		
No.	**μ Ci/cc**	**% MPC**

CONTAMINATION	
No.	**dpm/100 cm^2**

LEGEND: ___ Radiation O Contamination Δ Airborne

Remarks

Reviewed By

Date

APPENDIX M

STUDENT LAB SCENARIO

JOB PLANNING FORMAT

TRAINEE'S NAME Mike Donnegan, Steve Springle

NAME OF JOB DESCRIPTION:

SKETCH OR DRAWING: (Trainee-made drawing as appropriate for the job).

See attached survey map.

MATERIALS REQUIRED: (Trainee figures materials for job, and inserts materials list here).

RO-2
survey maps
Radeco air sampler
smears
wipes
air filters
plastic bags

PROCEDURES AND REFERENCES: (Trainee lists procedures and references to be used).

JPM for radiation survey
JPM for contamination
JPM for airborne survey
Operating procedures
Student Text

SP 62.010.01 General rad survey techniques
SP 62.020.01 General contamination survey techniques
SP 62.030.01 Airborne activity survey techniques

LABORATORY WORK: (Trainee sequences work step by step).

There has been a radioactive spill in the radiochemistry lab.
A technician dropped a coolant sample on the floor, setting off the airborne alarms.

1. Rope off area to eliminate access.
2. Take air sample to see if respirators are needed, following JPM.
3. Take radiation readings using RO-2, following JPM.
4. Take smears and wipes to assess contamination levels, using JPM.
5. Record all data on survey map using standard symbols.

EVALUATION: (Trainee determines criteria for successful completion of job).

JPM's completed step by step; students pair up, one evaluates while the other performs.

Completed survey maps turned into instructor.

The instructor must sign this sheet before a trainee is permitted to begin.

DATE ____________ **INSTRUCTOR'S APPROVAL** ____________________

APPENDIX N

INSTRUCTOR EVALUATION

Shop or Laboratory Rating Sheet

Directions:

Please circle SA (Strongly Agree), A (Agree), D (Disagree), SD (Strongly Disagree), or N/A (Not Applicable) for the following statements. Include a clarifying written comment you deem necessary.

INSTRUCTOR EVALUATION LAB/SHOP FORM

1. The instructor stated the objectives and purpose of the lesson and related them to experiences and needs of the students.

   SA [✓ A] D SD N/A

   COMMENTS: Board outline / good handouts / questioning of students

2. Pre- lab./shop sessions were effective as students knew what to do, teams were formed, objectives were clear, safety was stressed, and evaluation standards and grading criteria were explained.

   SA [✓ A] D SD N/A

   COMMENTS: ______________________________

3. The lab./shop learning material was well organized, logical, and easy to follow; and new words, terms, equipment, tools, and devices were explained.

   [✓ SA] A D SD N/A

   COMMENTS: very clear handouts, presented in sequence with explanation.

4. The instructor created a professional atmosphere in demeanor and attire, and in the physical aspects of the space and the instruments/tools/machines placed within.

   [✓ SA] A D SD N/A

   COMMENTS: good strong voice / jacket and tie / tools neatly arranged

5. Experiment/project assignments in the lab./shop were clear, current, relevant to the lesson, realistic, and provided for immediate feedback.

   SA [✓ A] D SD N/A

   COMMENTS: ______________________________

6. Classroom sessions and shops/labs. were closely aligned progressing from theory to practice.

   SA [✓ A] D SD N/A

   COMMENTS: Excellent pre-lab discussion

7. Sample, appropriate and sufficient tools, job/lab. sheets (easy to read, easy to follow, without error) were available to allow every student the opportunity to complete the work assignment.

SA [✓ A] D SD N/A

COMMENTS: ______________________

8. The lab./shop was arranged so that the instructor could be seen and heard by all students.

SA [✓ A] D SD N/A

COMMENTS: ______________________

9. The instructor planned for the readiness (past experience, knowledge, skill) of the class.

SA [✓ A] D SD N/A

COMMENTS: ______________________

10. The instructor provided adequate information about initial conditions, and sufficient theory and information was given at each step on each project.

[✓ SA] A D SD N/A

COMMENTS: clear and very helpful

11. The instructor demonstrated on his own project and monitored student progress on their own projects.

SA A D SD [✓ N/A]

COMMENTS: ______________________

12. The instructor was well versed in operating or demonstrating lab./shop machines and equipment.

SA [✓ A] D SD N/A

COMMENTS: ______________________

13. The instructor stressed the responsibility of each position in a work team and requested both individual and team feedback.

SA [✓ A] D SD N/A

COMMENTS: ______________________

14. The instructor was able to distinguish performance differences and guided individuals toward working effectively as a team.

SA A D SD [✓ N/A]

COMMENTS: ______________________

15. The instructor encouraged self-assessment, team-assessment, and maintained a lab./shop conducive to independent study and growth.

[✓ SA] A D SD N/A

COMMENTS: ______________________

16. The instructor was prepared for differences in performance rates of individuals and of teams, and tried to reach each person with the mastery of one objective during each session.

SA [✓ A] D SD N/A

COMMENTS: ______________________

17. The instructor exhibited good coaching/assisting techniques and did not interfere or take over students' work.

[✓ SA] A D SD N/A

COMMENTS: Excellent questioning technique

18. The instructor was constantly monitoring, asking for clarification, and never spending much time with any one student, group, or team.

SA [✓ A] D SD N/A

COMMENTS: ______________________

19. The instructor referenced plant practice or incidences intermittently as appropriate when discussing progress with the teams.

SA [✓ A] D SD N/A

COMMENTS: ______________________

20. There was sufficient time for student practice before performance exams.

SA [✓ A] D SD N/A

COMMENTS: ______________________

21. Non-verbal messages helped keep the lesson moving toward meeting the objectives.

SA A D SD [✓ N/A]

COMMENTS: not a lesson

22. Lab./shop reports, oral reports, and assignment were accurately graded or marked with complete written evaluations and returned promptly.

SA A D SD [✓ N/A]

COMMENTS: ______________________

23. The practice exercises were of various degrees of difficulty to allow for all students to achieve and quick study individuals to be challenged.

SA [✓ A] D SD N/A

COMMENTS: ______________________

24. The instructor acknowledged and recognized the effort and quality of the work performed by students as they progressed smoothly from one activity to the next.

[✓ SA] A D SD N/A

COMMENTS: praise of students at each important student performance

25. The development of special skills and knowledge were encouraged for students' exhibiting interest and ability.

COMMENTS: ________________________ SA [✓ A] D SD N/A

26. The instructor met the overall session objectives and was effective in dealing with individuals and the team.

COMMENTS: smooth, strong, organized and pleasant presentation [✓ SA] A D SD

APPENDIX O

SUMMARY STUDENT COMMENTS

SMALL GROUP

PROGRAM/COURSE/MODULE/LESSON COMMENT SUMMARY FORM

NAME: Don Drinkwater

Instructional Technologist

DATE: 3/15 – 3/17 and 3/8 - 3/10

Comment Package #: LP/LAB Tryouts **Date of Class:** 3/15-3/17 / 3/8 - 3/10

Program: HRT

# of Surveys Received: 2+2 ☐ mid course [2+2] end course

In the interest of developing and maintaining training programs of high quality and standards which meet the needs of the student, your comments on the following statements would be greatly appreciated. Please circle your response on a scale of 1 - 4 on questions 1 - 11 only. Write your comments for questions 12 and 13 in the space provided.

1. The subject matter was presented clearly and sequenced in a logical manner.

[✓ 4] 4	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

2. The objective(s) of the lesson(s) clearly stated the intent of the lesson.

[✓ 4] 3	[✓ 3] 1	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

3. The subject matter was pertinent to the job area.

[✓ 4] 2	[✓ 3] 1	[✓ 2] 1	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

4. The objectives were fully covered in the lesson material.

[✓ 4] 2	[✓ 3] 2	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

5. The lesson activities, e.g. demonstration, labs, practical exercises, question and answer session, were helpful in learning the lesson material.

[✓ 4] 4	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

6. The amount of instructional time spent on each topic was appropriate.

[✓ 4] 4	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

7. The handouts/student text and the graphic aids were helpful in understanding the lesson.

[✓ 4] 4	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

8. Sufficient time was given to prepare for exams.

[✓ 4] 3	[✓ 3] 1	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

9. The test(s) questions were related to the lesson material covered.

[✓ 4] 4	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

10. A review of the exam(s) was provided.

4	3	2	1	[✓ N/A] 4
Strongly Agree	Agree	Disagree	Strongly Disagree	

11. The test directions were clear.

[✓ 4] 4	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

12. List any general recommendations that would improve the course/module (respond to use of a-v/graphics).

1 - not applicable to job
2 - more survey examples
1 - more surveys and RWP, more practice

13. Please describe how instruction was or was not appropriate to your level of understanding.

1 - not applicable to job
2 - appropriate
1 - no comment

APPENDIX P

SUMMARY STUDENT COMMENTS

PILOT TEST

PROGRAM/COURSE/MODULE/LESSON COMMENT SUMMARY FORM

NAME: Don Drinkwater

Instructional Technologist

DATE: 3/22/89

Comment Package #: LP/LAB Pilot Test **Date of Class:** 3/20 - 3/22

Program: HRT

# of Surveys Received: 6

	6
mid course	end course

In the interest of developing and maintaining training programs of high quality and standards which meet the needs of the student, your comments on the following statements would be greatly appreciated. Please circle your response on a scale of 1 - 4 on questions 1 - 11 only. Write your comments for questions 12 and 13 in the space provided.

1. The subject matter was presented clearly and sequenced in a logical manner.

[✓ 4] 5	[✓ 3] 1	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

2. The objective(s) of the lesson(s) clearly stated the intent of the lesson.

[✓ 4] 6	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

3. The subject matter was pertinent to the job area.

[✓ 4] 5	[✓ 3] 1	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

4. The objectives were fully covered in the lesson material.

[✓ 4] 6	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

5. The lesson activities, e.g. demonstration, labs, practical exercises, question and answer session, were helpful in learning the lesson material.

[✓ 4] 6	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

6. The amount of instructional time spent on each topic was appropriate.

[✓ 4] 5	[✓ 3] 1	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

7. The handouts/student text and the graphic aids were helpful in understanding the lesson.

[✓ 4] 6	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

8. Sufficient time was given to prepare for exams.

[✓ 4] 5	[✓ 3] 1	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

9. The test(s) questions were related to the lesson material covered.

[✓ 4] 6	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

10. A review of the exam(s) was provided.

4	3	2	1	[✓ N/A]
Strongly Agree	Agree	Disagree	Strongly Disagree	

11. The test directions were clear.

[✓ 4] 6	3	2	1	N/A
Strongly Agree	Agree	Disagree	Strongly Disagree	

12. List any general recommendations that would improve the course/module (respond to use of a-v/graphics).

3 - additional comprehensive lab (surveys)
1 - add one day
2 - no comment

13. Please describe how instruction was or was not appropriate to your level of understanding.

1 - appropriate if plant operators
5 - appropriate

APPENDIX Q

INSTRUCTOR END OF COURSE EVALUATION

LILCO

OFFICE OF TRAINING

INSTRUCTOR'S COURSE ASSESSMENT FORM

Instructor's name Len Engel Date 3/22/89

Course/title/number HRT
Radiological Assessment Skills Training

Your assessment of this training course is needed. This form is divided into course background questions and course assessment questions.

Thank you for taking the time to complete this form thoughtfully and completely. Your responses are essential in identifying strengths and weaknesses, and recommending needed improvements.

Upon completion, please submit this form to the respective Instructional Technologist assigned to your group.

This Office of Training form should be distributed to instructors and read by each instructor prior to his teaching any course. It must be completed at the end of the course.

I. **COURSE BACKGROUND** Radiological Assessment Skills Training HRT
Course title/number

1. Has this course been taught before? yes/no no

2. How often have you taught this course? NA

3. How long have you been teaching in this discipline? 10 years

4. Did you help develop the material? yes/no yes, I developed the program

5. Have you conducted tutorial sessions? yes/no no

6. Have you conducted counseling sessions? yes/no no

Please explain any yes answers. I developed this course following DACUM Analysis

II. **COURSE ASSESSMENT**

1. Name or list the lessons that need to be made more precise to ensure repeatability.

HRT-LP-01 HRT-L01-01
Lesson Lab.

2. List the lessons that need to be changed and state the reason(s) why.

The "survey pifalls" brainstorm needs to follow the lab, not the lesson. Momentum from the lesson needs to be channeled directly into the lab. Ear noise protection needs to be provided when using Compressor Room.

3.a. Pick out the ~~five~~ most effective lesson~~s~~ and state the reason(s) for your selections.

The comprehensive lab. with simulation of radiation, contamination & airborne.

b. Pick out the ~~five~~ least effective ~~lessons~~ item and state the reason(s) for your selections.

The debate on "posting" was no debate at all everyone agreed that posting mistakes occur all the time.

4. List the lessons that are not sequenced appropriately and explain the basis for your conclusion.

Sequence Brainstorm & case study after lab, as an effective summary of lesson.

5. Has the content of the course been absorbed by the students (as exhibited by student scores, surveys, and interviews)? Explain the basis for your answer.

Mastery of objectives was required

6. Have students with unsatisfactory performance been given remedial/developmental training, recycled through training, or removed/failed? Cite specific examples. Were appendices 8.1 and/or 8.2 of OTP 5.01 filed?
Yes____ No_X___

7. Describe all the methods used to evaluate students' performances. Include sufficient time to study for exams. Do more or fewer tests need to be given? Please explain.

Three short essay progress checks were given. Three survey maps were required. The final comprehensive lab. included survey maps and JPM

8. If you have made minor changes on lesson plans or other instructional material, please attach or briefly describe those changes. Were TMU's submitted in accordance with OTP 6.02?
Yes___ No___ NA X

The class was formative.

9. If you believe major changes are needed, please describe and document whenever possible all the changes desired. Have TMTR's been submitted in accordance with OTP 6.02?
Yes____ No____

NA

10. How and when were students informed of their progress? Be specific with test and other progress report dates.

At the end of each part of the lesson (3 parts) and at the end of the comprehensive lab. The progress checks (short essay), survey maps, and JPM's were discussed.

11. Describe the effect the background of the class had on the level of the course material.

Those students without Navy nuclear experience needed to see the slide/tape on "ionizing radiation".

12. Please relate any other concerns or thoughts you may have for course improvements including use of audio-visual aids, time periods allocated, and practical applicability of instructional activities.

When contractors are in the class, include the "ionizing radiation" slides

APPENDIX R

THREE AND SIX MONTH EVALUATION FORMS

OFFICE OF TRAINING

STUDENT THREE MONTH COMMENT FORM

The Office of Training would like your reaction to the training you received as indicated on the following pages. The form is divided into general information questions and a tasks matrix to complete.

Thank you for taking the time to fill out this evaluation thoughtfully and completely. Your response will help the Office of Training to improve your training and that of your co-workers.

Name: ____________________ Supervisor's Name ________________/ Work Location ____________ 3

Date Completed: ____________________ Comment Package # __________

Program/Course/Module Title/Number: ____________________________

Thank you very much for time. Please feel free to make any additional comments, remarks or suggestions which may help the training program meet your needs.

Signature: ________________________________

(optional)

Return to: Office of Training, Program Development Supervisor by:

____
month / day / year

GENERAL QUESTIONS:

1. Was the training attended related to your current work routine?

Y / N

2. How have the knowledge and skills received from the course affected either your overall work performance or specific work areas?

3. Are there any skills that you routinely perform on-the-job pertinent to the training topic that were either not covered, or that you believe were insufficiently covered with the program?

Please be specific in your answer.

4. Would you add or delete anything to the course to make it more effective or interesting? Y / N

If yes, please be specific.

5. Now that you have had the opportunity to apply the training to your job, please attempt to identify the MOST USEFUL and LEAST USEFUL items of training received pertinent to your work.

MOST USEFUL

LEAST USEFUL

TASKS MATRIX

The following tasks have been specifically selected by the training supervisor as being indicative of the work performed during the three months following training.

Rate the instruction on the tasks selected using the following scale: 1 - EXCELLENT 2 - ABOVE AVERAGE 3 - BELOW AVERAGE 4 - POOR

		INSTRUCTION			
TASKS	NOT PERFORMED (put a X)	SUFFICIENT COVERAGE	ADEQUATE DEMONSTRATION	AMPLE PRACTICE	HOW OFTEN PERFORMED
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					

If further explanation is needed to clarify any of your rankings please comment on the space provided.

SUPERVISOR THREE MONTH COMMENT FORM

Program/Course/Module: **Date Completed:**

Supervisor's Name: **Dept:**

Comment Package #:

Names of Students who have completed the Program/Course/Module:

(NAME) (COMPLETION DATE)

The individuals listed have completed job specific training. Your comments on how the training affected your workers' performance is important to ensure that each training program is effective in teaching requisite knowledge and skills.

Thank you very much for your time. Please feel free to make any additional comments, remarks, or suggestions which may help the training program meet your needs.

Signature:

Return to: Office of Training, Program Development Supervisor by:

month / day / year

SUPERVISOR THREE MONTH COMMENT FORM

1. Have you noticed an overall improvement in performance of the latest group that was trained? Please explain.

____

____

____

____

2. Please list any weaknesses in workers' performance that you believe should be included in their training.

____

____

____

____

3. According to the overall performance of this group what do you perceive were the MOST USEFUL and LEAST USEFUL items of training?

MOST USEFUL

____

____

____

____

LEAST USEFUL

____

____

____

____

4. Please describe any employee feedback regarding this training, positive or negative.

5. Please provide any other comments you have that will help increase the effectiveness of your employees' training.

6. Please provide any specific skill or knowledge you, as a supervisor, were required to provide.

7. Could this information be provided in the training environment?

yes [ ]   no [ ]

TASKS MATRIX

The continual improvement of training is our constant goal. Your responses to how your workers performed these tasks as a result of training can help us focus on areas that need to be improved.

Rate the workers' performance on the tasks selected using the following scale: 1 - EXCELLENT 2 - ABOVE AVERAGE 3 - BELOW AVERAGE 4 - POOR

	WORKERS' PERFORMANCE				
TASKS	NOT OBSERVED (put a X)	SELF-CONFIDENCE	PRACTICAL ABILITY	KNOW-HOW	PROBLEM SOLVING
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					

If further explanation is needed to clarify any of your rankings please comment on the space provided.

Appendix 8.8
Page 1 of 1

PROGRAM/JOB PERFORMANCE COMMENT FORM LOG

Log in number in sequential order with program code	Date Class Ended	Date course summaries completed		Instr. Eval. rec. ( )	Student and Supervisor 3 Month Comment Forms. Indicate how many were sent out and dated, and how many were returned and date for both forms.				Student/Supervisor 3 month Summaries sent to TAS/Date
		mid	end		Student		Supervisor		
					Sent	returned	sent	returned	
					Date	Date	Date	Date	

APPENDIX S

OJT PLAN

ON-THE-JOB TRAINING AND QUALIFICATION GUIDE FOR THE RADIATION WORKER

NAME: ______________________________ **SSN:** __________________

TITLE: RADIOLOGICAL SURVEYS

INSTRUCTIONS

On-The-Job Training

The qualified trainer will demonstrate each element of the task as described in the Job Performance Measure. The trainer will then guide the worker through each performance step, assisting as required

Hands On Practice

The worker may practice each step of the task while performing under the supervision of a qualified individual. This is to gain experience and competence in preparation for qualification.

The worker should use the JPM as a guide to ensure job performance to the standards required. When ready for qualification, the worker will inform the evaluator/supervisor.

Qualification

The evaluator shall review the acceptance standards for each step of the tasks to be performed. The review is to ensure the standards reflect the most recent procedure revision cited in the references.

The evaluator shall initiate the qualification performance test by informing the worker of task initiation, and the conditions under which the task will be performed.

The evaluator shall test the worker on each element of the task to the standards specified in the JPM. Unsatisfactory performance shall require continuation of OJT and hands-on practice. Satisfactory performance is indicated by the evaluator's signature and date on the JPM.

APPENDIX T

PETE

NUCLEAR TRAINING CENTER
PERFORMANCE EVALUATION OF TRAINING EFFECTIVENESS (PETE)
OBSERVATION FORM

STATION: S - HC JOB CLASSIFICATION(S) ______________________________
DATE: ______/______/______ OBSERVER(S) ______________________________
TIME(S): ______________________

WORK ORDER # ______________/IOS # ______________/JTA # ______________/DUTY AREA ______________
JOB DESCRIPTION:

OBSERVATION/EVALUATION ITEMS	OUTSTANDING	SATISFACTORY	UNSATISFACTORY - WHY?
1. Did personnel follow approved Procedure(s)? a. Procedure #: AP-31 (Cleanliness) b. Procedure #: ______________ c. Procedure #: ______________ d. Procedure #: ______________ e. Procedure #: ______________ f. Procedure #: ______________			
COMMENTS:			
2. Did personnel use proper tagging verification procedures?			
COMMENTS:			
3. Were there delays in commencing job due to improper planning? a. List: ______________ ______________ ______________			
COMMENTS:			
4. a. Were proper tools pre-staged for the job? b. Was proper tool usage observed?			
COMMENTS:			
5. Was calibration verification observed?			
COMMENTS:			

OBSERVATION/EVALUATION ITEMS	OUTSTANDING	SATISFACTORY	UNSATISFACTORY - WHY?
6. Were ALARA concepts followed?			
COMMENTS:			
7. Were Safety Procedures followed?			
COMMENTS:			
8. Were communications between departments effective? SSS: ____ SS: ____ RO: ____ HP: ____ Security: ____			
COMMENTS:			
9. QA/QC involvement observed?			
COMMENTS:			
10. Did the job performance indicate the worker understanding of basic theorical knowledge?			
COMMENTS:			

Skill Observation

OBSERVATION/EVALUATION ITEMS	OUTSTANDING	SATISFACTORY	UNSATISFACTORY - WHY?
11. During performance of the job, what skills were observed? a. ____ b. ____ c. ____			

COMMENTS:

*Significant Change Recommendations:

* Proposed Actions:

Activity	To be Completed By	Date Completed
1.		
2.		

Submitted By: ______ Approved By: ______

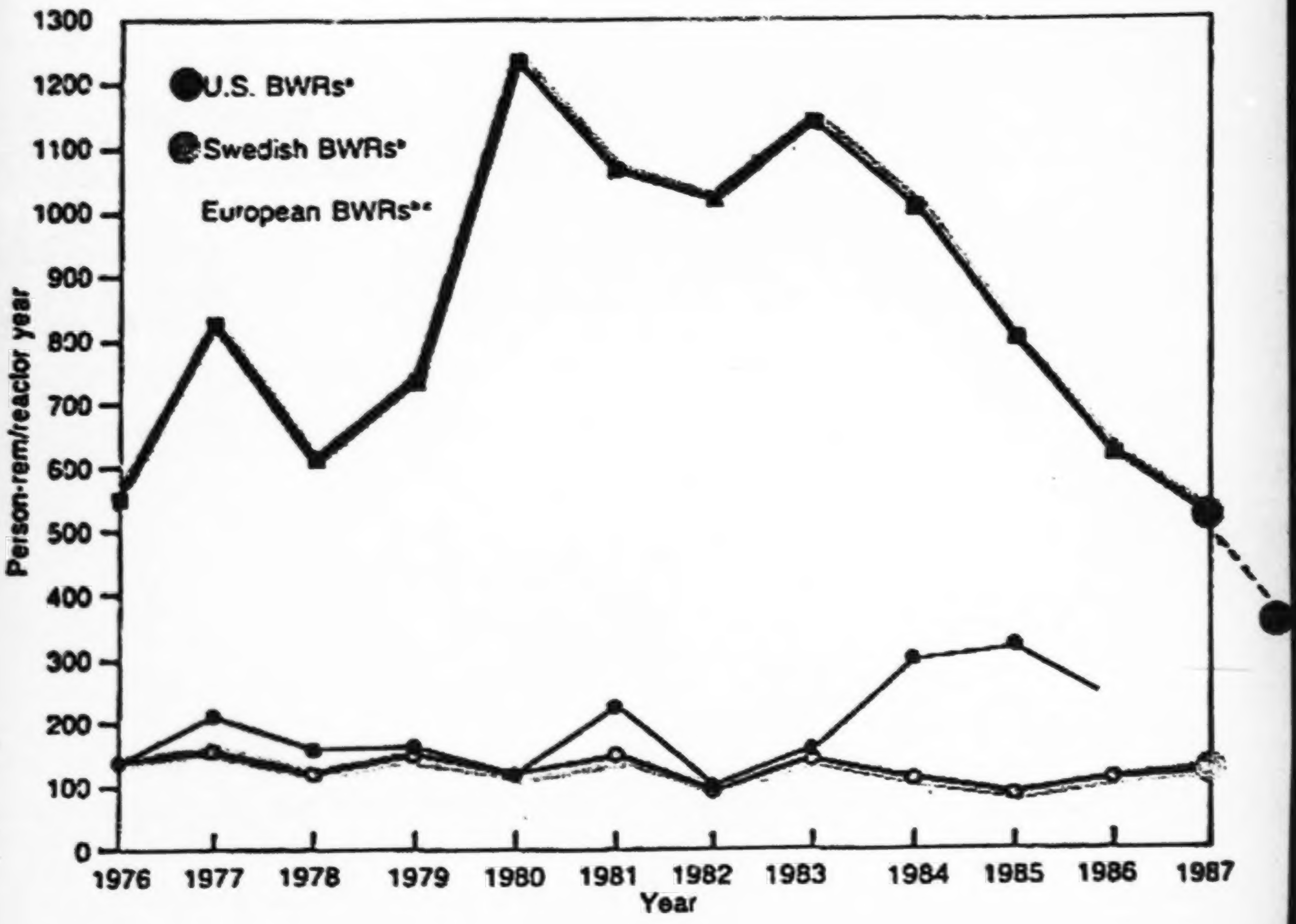
______ Date: ______ ______ Date: ______

Prin. Training Supvr./
Training Supvr.

Training Department Head

APPENDIX U

PERSON-REM PER REACTOR YEAR


U.S. BWRs*
Swedish BWRs*
European BWRs**
Person-rem/reactor year
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Year

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